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STREET CLEANING IN PARIS.

By H. VIVAREZ.

LONDONERS are commencing to have a lively appreciation of the inconveniences to be experienced during the present winter from the incompetence shown by the municipal and district authorities in removing snow from the streets, and dealing with mud and slush resulting from subsequent thaw. The sense of grievance, which finds a very inadequate vent by the usual channel dear to injured Englishmen—the columns of the daily journals—is aggravated by the remembrance of the tax collector, whose demands appear to increase in about the same ratio as municipal efficiency diminishes. Possibly police delinquencies, and the swift retribution that seems likely to fall on that branch of the public service, may have a stimulating effect on effete vestries, and sluggish local boards, and warn them that though the public is long suffering there are limits set to its patience; possibly, and this is the pleasanter though perhaps less probable anticipation of the two, we may not have a continuation of a winter so disagreeable as its commencement has proved. Meanwhile it will be of interest, and perhaps useful to examine into the methods adopted by the Municipal Government of Paris, which has a high reputation for doing its duty thoroughly and promptly.

It may probably be taken as granted that Paris ranks first among all large cities, in the care that she takes of her streets; still much is left to be desired in the way of cleanliness, which would tend to raise the standard of health in the city. Until the reign of Philippe Auguste, the streets of Paris were little better than open sewers. "In the year 1185," says an old chronicler, "the king absorbed in affairs of state, in the Palais Royal, would sometimes after pacing to and fro in the rooms, station himself at the windows, to amuse himself by watching from a distance the flow of the Seine. Vehicles drawn by horses, and traversing the Cité, constantly stirred up the mud, and caused intolerable exhalations. The king was not able to stand this, for the evil smells pursued him to the innermost parts of his palace. Upon this he conceived a scheme, very difficult of execution, but of an absolute necessity, a project that none of his predecessors had dared to undertake on account of the great expense, and the serious obstacles that would have to be overcome. The king convened the burgesses and the provost of the town, and ordered them to pave with strong and hard stones, all the streets and ways of the Cité." This was a royal road out of a difficulty, but comparatively a successful one. A gentleman, who had a certain control of the king's finances—Gérard de Poissy—contributed eleven thousand silver marks to the work. The reform, however, was only very limited, the paving being confined at first to the two streets called the Croisée de Paris, which intersected each other at right angles in the middle of the town. It was done with large square slabs, measuring about 40 in. on a side, and from 6 in. to 9 in. in thickness. In modern times, vestiges of this pavement have been found when excavations were made in the Rue St. Jacques. The name Rue des Petits Carreaux, is probably derived from the dimensions of the stone slabs used in paving it. Such was the first effort made in Paris towards the maintenance of the public ways and the transformation of streets, which until then had always remained unpaved and uncleansed, full of débris and abominations, that engendered perpetual miasma, and gave birth, from time to time, to plagues and epidemics that ravaged the helpless population. The very names given to the streets testified to their condition, and would not bear repetition in these later days.

This state of things, despite the example set by the sanitary monarch above referred to, lasted for an intolerable time. It was not, indeed, until the reign of Charles V., that the first effort to construct sewers that should carry off the foul and stagnant water which corrupted the air, was made in Paris. With this also serious attempts were made at paving and cleaning the streets. But this work was carried on without system, and there remained very many poisonous districts, known under the expressive title of "*trous punaises.*" During the captivity of Francis I., large sums were expended in the fortification of Paris. In 1525, five hundred workmen were employed at a daily wage of twenty deniers, to level a large number of mounds formed in the city by long accumulation of rubbish. Several streets were paved, and the Quai du Louvre was constructed, together with many other works of the same class, during the second half of the sixteenth century.

Nevertheless the condition of the public roads was so defective, that at the end of the reign of Louis XIII., a historian of Paris drew the following sombre picture. "In the town we see the streets very narrow and tortuous, bordered at intervals by large and massive buildings, the intervals between which are filled with ill-built houses, or rather hovels; occasional opulence is surrounded by almost perpetual misery." And the condition of the streets was as bad as that of the bulk of the houses between which they ran. Evil of smell, and choked with mud, obstructed often by heaps of filth, which were bathed by pools of stagnant and poisoned water, they attacked all the organs of sensation at once. From the *procès-verbaux*, that were drawn up in 1636, concerning the streets of Paris, the deplorable condition in which they still continued, may be realised. Streets still remained wholly unpaved; débris and filth were accumulated in heaps in front of the houses, where they had grown undisturbed for many years; others obstructed the middle of the roads, where they stopped the watercourses, and closed the mouths of such sewers as were in existence. These sewers themselves were choked, and tumbling into ruin. The surface water finding no outlet accumulated in the streets, and other open places, forming large sheets of water interfering with the traffic, and were active centres for the creation and spread of disease among the inhabitants of the adjoining quarters. These *procès-verbaux* are little but continuous censures of the Government, administrators, and police, and contain full justification to the poets of the period who stigmatised Paris as a *Ville de boues, Ville de fanges et de crottes*, &c. The poets in this instance fell far short of truth.

Paris, said an old French historian, was like a poor and proud man, wearing gilded clothes over dirty and ragged under garments. This deplorable state of things was somewhat remedied by Louis XIV. During his reign, the bourgeoisie of Paris contributed 300,000 livres a year for the cleaning and lighting of the streets, but in 1704, the king, short of means, proposed to the Parisians to compound this annual tax by a single payment. The citizens accordingly subscribed 5,400,000 livres, and in return obtained a royal decree, relieving them in perpetuity, and irrevocably, from the charges of cleaning and lighting the streets. Following this, several streets were widened and made comparatively decent, and some new quays were built. Nevertheless, the condition of things was such, that a foreigner visiting Paris was justified in giving the following description of the capital: "Quoiqu'il ne pleuve pas, on ne laisse pas de marcher souvent dans la boue. Comme l'on jette tous les immondices dans la rue, la vigilance des magistrats ne suffit pas pour les faire nettoyer. Les dames ne vont plus qu'en mules. Les hommes ne peuvent marcher qu'avec des bottes. Un Espagnol les voyant en cet équipage le jour de son arrivée demanda si toute la ville partait en poste." However, several real improvements were effected, and during the reigns of Louis XV. and XVI., considerable works were completed. In 1780 the chief of police offered a prize of 600 livres for the best memoir on the cleansing of the streets, and from this there resulted an order which did something towards abating the worst of the evils. During the early time of the revolution, the suppression of the octroi under the pressure of public opinion, removed a source of revenue, which was not replaced by anything else. Everything suffered in consequence, the roads were wholly neglected; half of the lamps were extinguished from lack of funds to pay for the oil, and the improved streets fast reverted to their original state of uncleanness. The 2nd Fructidor, year vi., the secretary of the Committee of Finances issued a report setting forth the situation; the scavenging service of the city had ceased to exist, the contractors refusing to do work for which they were not paid. There were 410,000 francs owing for lifting and carting mud; 450,000 francs for paving; 420,000 francs for lighting; even the sweepers were owed 16,000 livres, and there was nothing to pay them. On the 24th Vendémiaire, year vii., the Council of the Five Hundred declared the necessity of restoring the octroi, and decreed that the whole of the proceeds should belong to the city, whereas previously two-thirds of it had been appropriated by the king. During the first year, from October 22, 1798, to October 23, 1799, this tax realised 7,500,000 francs. The last time it had been collected under royalty (1790) it amounted to almost 36,000,000 francs. The cleaning of the public streets was intrusted to the prefect of police by the consular decree of 12th Messidor, year viii., but improvement in the service was very slow. At the end of the reign of Louis Philippe, although side walks were to be seen in some of the main streets, most of them were destitute of this accommodation. "I vividly remember," says Maxime Ducamps, "the streets of Paris at this time; they appeared specially arranged to insure the choking up of the sewers. Hollowed transversely, and traversed from end to end by a gutter in the middle, they centralised the surface water, which is now thrown on to each side of the road by the form always adopted. At intervals the water flowed into the sewers by an iron grating, the openings in which were usually

obliterated by straw, stones, and rubbish of all kinds, floated there by the current. From time to time the wheel of a passing wagon would roll over one corner of the grid, and jerk it from its seat into the road, leaving the opening to the sewer unprotected. Sometimes the entrances to the sewers were so large that they resembled the inlet to a cellar; the raised gratings which protected them did not protect the side, in order that the passage of large objects may not be impeded, and the clear space thus left above the pavement was such that children playing in the street have rolled into the sewers and perished."

During this long period, when the state of the public roads was so unsatisfactory, the legislation on the subject of street scavenging had been very considerable, showing at the same time the extent of the evil, and the efforts that had been made to reduce it.

The following *résumé* shows briefly to what extent legal measures had been taken:

In 1285, letters patent were granted to Philippe le Hardi, which was the first attempt at regulating the cleaning of the public streets.

In 1348, a rule was issued by the Provost of Paris, inflicting a fine of three livres for each householder who neglected to clean and repair the pavement in front of his dwelling.

On January 30, 1356, letters patent issued by King Jean confirmed the ordonnance just referred to.

On March 1, 1388, and April 3, 1399, the previous regulations were further confirmed and extended.

On January 25, 1539, a royal decree was issued, imposing on the citizens the duty of cleaning the road in front of their doors.

In 1563, a law was passed embodying and extending all previous decrees.

In 1607, an edict was issued relative to the maintenance and repairs of paving.

In September, 1608, letters patent were granted, enjoining proprietors and tenants of houses, under pain of a fine of three livres, to collect and keep within their houses, all refuse, and to carry them to the carts employed for the purpose, at the moment of their passing.

On May 29, 1639, an Order of Council called upon the Provost of Paris to take charge of the pavement and of the street cleaning.

On May 31, 1666, an ordonnance of finance bureau was published relating to the regulations of the streets.

Decrees of April 1, 1667, and March 8, 1668, prohibited making excavations in the street without previous authority.

A decree of May 22, 1725, referred to works of levelling and regulating the streets.

On March 23, 1736, a law was passed prohibiting throwing refuse, &c., into the sewers.

Ordonnances of April 8, 1766; August 2, 1774; December 12, 1780; and November 28, 1783, related to planting trees, excavations, &c.

Lastly, on December 5, 1846, an ordonnance of police reminded the proprietors and tenants of houses of their obligations to sweep the road in front of their dwellings at certain hours, the city scavengers being at liberty only at other times. The decree contained, moreover, a clause, providing that foreigners should be at liberty to contract for the scavenging of the streets. This clause was the origin of the organisation of the various scavenging companies, but the privilege was removed by the police order of September 1, 1853, concerning the sweeping and cleaning of the public ways and the transport of refuse. This decree provided that proprietors and tenants should be obliged to sweep completely and every day the pavement and the centre of the road in front of each house, shop, court, garden, &c. The mud and refuse had to be collected in heaps, and the work was to be carried out between five and six in the morning during summer, and between six and seven in the winter.

The scavenging companies above referred to disappeared gradually after this edict came into force, and the Administration entered into contracts with the householders for the removal of the refuse, based on three scales of charges: .48 fr., .36 fr., and .24 fr. per square metre per annum.

The work of removing the mud, &c., thus accumulated was done by contractors, who were bound to take it away every morning, under fixed conditions and charges. The material removed became the property of the scavengers, who carted it outside Paris, and sold it to the market gardeners.

For this system of scavenging certain routes decided on from year to year, were regularly followed. At first, when the streets of Paris were not rounded, falling from the centre to each side, but made hollow, with longitudinal gutters in the middle, the mud, technically called *gadoues*, was highly charged with organic matters, and was well suited for manure. Since, however, the establishment of the modern type of road, and the development of the system of washing the streets, the refuse has gradually lost its original characteristics, and as a result, the receipts from its sale have diminished, till they first disappeared, and afterwards became a considerable source of expense.

The legislation last referred to, was enforced during the whole period of the Empire, and until the promulgation of the ordonnances actually in force.

(*To be continued.*)

THE NATURAL HISTORY OF LOCAL BOARDS.

III.—The Fighting Board.

Long before the present age—which may be called the age of Local Boards—a pleasant village marked the site of an old Roman ford just below the junction of two fine trout streams in the northern counties of England, at a point where their impetuous currents from the uplands had changed into a sedate and tranquil flow along a rich and level valley. It stood at the meeting of the coal measures and the magnesian limestone, and being remote from the coal outcrop, no sign of that growing industry as yet defiled its quiet lanes and river meadows; nor did any other industry of a mechanical kind occupy its few inhabitants, who lived chiefly by farming, malting, lime-burning, and the grinding of corn at the ancient water mill. The two trout streams had become navigable more than a century before local government was thought of, and long before that, a series of broad mill weirs, many long miles apart, had converted them into rivers, gliding brimful through a fat alluvium, in some places 15 ft. or 20 ft. deep in greasy black silt, and mostly subject to flood for several hundred yards on each side; at the margins rose ridges of low elevation, with wooded summits four or five miles apart.

Half a century ago the village had barely 1500 inhabitants, and the place was reputed healthy, as low-lying villages go. About that time, however, railways began to score the face of the world. Our pleasant little village shared in the transformation. A main line was made through it. Long since the trout had vanished before the irresistible march of manufactures, which, now hastened threefold, soon converted the clear waters into an inky and malodorous fluid, destructive of animal life. Coal-mining crept nearer as the top seams became worked out, though still miles distant. The canalised river and its "cuts" bore up and down their surface an ever-increasing fleet of barges. Then it was that a young man whose indomitable energy and tenacity of purpose did credit to his Saxon name, took counsel to himself and built him a small glass works, which grew in size. He then built another on a great tongue of land almost girt by the river. The land was cheap; coal easily brought down stream in barges to a little wharf; sand, lime, and clay were equally accessible; the double navigation commanded one of the richest and most populous manufacturing centres in the world; and finally, the new railway station put the coping-stone on the whole, making the peaceful village into as fine a site for an industrial capital as the kingdom could show.

With these advantages, and an able administration, it is no wonder that the modest works grew into a vast and flourishing concern, covering acres of land, and supplying a considerable section of the world with eating and drinking vessels of infinite variety. Others followed, rearing their unsightly cones on all sides, and belching forth clouds of black smoke without let or hindrance. The older trades waxed bigger, other trades were established, and chemical works, hunted out of older centres, here found a haven of rest, where the wicked ceased from troubling, and liberty of poisoning and being poisoned reigned supreme.

The usual blighting metamorphosis ensued. Ten or fifteen years of the preliminary scramble for wealth without local government, or guiding social influences, did its work. It made an unkempt, ash-covered, smoke-begrimed, mud-bespattered wilderness of the place; a human beehive, wanting the order, cleanliness, and finish of its prototype, and tenanted by beings whose brief lives were an every-day tragedy of drink, dirt, disease, and death.

Groaning under these sore afflictions, the inhabitants looked round for help. The present universal division of all the townships and parishes of England into urban and rural sanitary districts, was not even dreamt of in those dark ages. Even the Local Government Board had no existence, dreadful as the reflection may be; and the now long extinct, but then new-born General Board of Health, perfunctorily filled its place, administering the Public Health Act in its earliest stages. Here was the way of relief pointed out to the more intelligent of the community; and spurred by the causes above mentioned, together with others of a special force, a petition was drawn up and signed, as was compulsory in the pre-Local Government Act days, by not less than one-tenth of the rated inhabitants of the township, and early in 1850 was despatched to the proper quarter.

A superintending inspector was sent down, and an inquiry held in the village schoolroom—the parliament house of the obscure places of the world. Evidence was taken, and the district carefully inspected by the inspector, who in due time presented his report to the General Board, descriptive of the geographical, meteorological, social, commercial, and sanitary conditions of the place. The salient facts were as follow:

The population had increased nearly 50 per cent. since the census of 1841, and was now over 2000, living in 450 houses, and engaged chiefly in the making of glass and hardware, besides the grinding of flint, whiting, and corn, and in sundry malt kilns. There was no system of water supply, a hard drinking water being pumped by hand from surface wells, and in a few cases lifted from draw-wells, while the rain-water caught in butts, tubs, and cisterns, furnished a soft supply for washing. The whole supply was both suspicious and precarious, for the shallow wells were closely allied to some 300 middens, cesspools, privies, and manure heaps, supplemented by an extraordinary contingent of pigsties, of which there was one to every four houses. The privies outnumbered the pigsties but little, both being apparently thought equally necessary. Even this scanty accommodation was not equitably distributed, there being sometimes as many as six, seven, or nine claimants to the use of one miserable closet; while to crown all, a group of eight forlorn cottages had neither a closet nor the right to use one, but had to subsist on the charitable consideration of their neighbours. In one case, indeed, a quarrel arose between the respective owners of the cottages, and the closet used by their tenants, as to the question of cleansing, which led to the production of a horrible nuisance, which no one would deal with—another curious result of "unexampled prosperity," one marked feature of which is to bring property into the wrong hands.

As for main drainage, there was none, as a matter of course; and in place thereof existed a solitary sewer in the main street, discharging its "ooze" into the river below the weir, and leaving behind it a residuum of black sludge, 18 in. deep, to defile the neighbourhood by the fumes emitted at a few road sinks. Not to be behind in liberating this elongated cesspool of its superfluous gases, a few owners effected open house and cellar connections with it, and thus not only laid on a plentiful supply of sulphuretted hydrogen—which in many cases lasted a lifetime—but also in times of flood, a fine inflow of turbid water from the swollen river, whereby no small portion of the sediment was effectually got rid of by the simple process of upward scour and deposit on the said cellar floors.

A solitary purling brook, the watering centre of the village, formed a convenient channel for refuse liquor from the gas works; its volume, reduced to a reasonable consistency by the contents of sundry privies and pigsties lining its borders, every now and again rose in rebellion against its confined limits, and avenged itself by penetrating the sandy strata to the cellars of the offending owners; sometimes carrying to the tenants its own warrant of ejection into another world. In one case, the rotten liquid was only kept down by a "sump" in the basement, daily exhausted by a pump in wet weather, and weekly in dry weather. But the drain and the brook received only a part of the sewage, the bulk whereof flowed into cesspools or middens, and percolated or overflowed at large into the porous soil, and greatly contributed to the water supply, as aforesaid.

Another pregnant evil was the state of the poorer dwelling-houses and cottages, many of which were copyhold, and were a mere parody on dwellings, little better than a huddled pile of dirt and dilapidation, sweating with damp. To escape from the curse of copyhold with its restraints, fines, exactions, and fees, builders did worse, and built in freehold swamps where stagnant water seized and fertilised the germs of cholera which then filled the air of Britain. Just without the township boundary was a large pool of standing water—an ancient and disused link in the winding river—bordered by a swamp, near to which a factory and a score or two of miserable cottages were erected—a forlorn little colony in which all the aforesaid evils were intensified, and which, although beyond the legal scope of the inquiry, the inspector recommended to be incorporated with the proposed district of Great End.

Over-population played another part in the dire comedy of human life in Great End; and a lower depth was reached by the crowding of these insanitary tenements, details of which were cited, shocking to humanity. Instances, too, of drains laid to imaginary sewers which had no existence, and then allowed to discharge their contents into the porous soil, were dragged into light, as well as agglomerations of butchers' offal fit to turn the gorge of a scavenger.

A room, containing 160 square feet of area, under a ceiling of 7¼ ft. high, was used as a dame school by day and a sleeping room by night; and when viewed by the inspector, thirty-three wretched scholars were found in it drinking in knowledge and carbonic acid at the same time. Other evils there were, squandered abroad in this devoted township; but enough has been said to show the true meaning of sudden "prosperity" to any community of small freeholders; the mushroom growth of human swineries.

The sum of the whole was that the place became a plague-spot, where the hand of death wrought merrily. Like the little village, the little churchyard became too crowded for new-comers, whose remains could only be accommodated by thrusting aside the old tenants—nay, sometimes of their immediate predecessors—so that even the common heritage of all, measuring six feet by two, became the subject of dispute. But the cheated dead had their revenge on the living, for when at last the most terrible form of death appeared in their midst—the *cholera morbus*—the purlieus of the graveyard, although by nature the driest and most elevated, suffered as much as the foulest swamp in the district.

Thus carried off like tainted sheep, the mortality of this feeble community increased from the extraordinary average of 27 in the 1000 to the still more extraordinary rate of 32 and 40 respectively for the last two years preceding the inquiry; while the mortality of children exceeded that of the most unhealthy great town in England—Liverpool.

After setting forth this indictment, the inspector's report proceeded to recommend the formation of a Board of Health district, comprising the whole of the township of Great End, together with the small abutting portions of two other townships, whose little colonies were the overflow of the village; a recommendation duly carried out minus the two outlying districts; another of those errors which, like all radical errors, are pitilessly dogged by their Nemesis. The report proceeded to recommend systems of sewerage and water works; the abolition of cesspools, and the conversion of privies into water-closets; the building of a public slaughter-house; and the establishment of a cemetery. The scheme suggested for a water supply (inspectors went much further in those days than now) may be thought singular now, when a high standard of purity is the rule. It was to allot forty acres of agricultural land as a catch-ground, to be deep-drained at a cost of 4*l.* an acre, to which, it was thought with a simplicity worthy of record, the landowner would be willing to contribute one-half or one-third of the cost, and to give the water into the bargain. With this exception, and a somewhat starved estimate of the cost of drainage works, made without sections or levels—a common trap for novices—the conclusions of the report were just and comprehensive, and made a good basis of action for the Great End Local Board of Health. We will see what use they made of it.

It was in the year 1851 that the Board was established, and notwithstanding the strictures of the inspector and the pitiful evidence of the petitioners, nothing was done by way of carrying out a system until 1868, when a universal water famine spread through the land and awoke the Board out of their seventeen years' slumber. It is true an old pit drainage level had been brought into requisition, and a little tank or cistern holding a few hundred gallons had been made by the river side, at the point where the level discharged its subterranean current. But the water had to be fetched by hand in buckets, which tired the patience of even the handful of long-suffering housewives whom it supplied. Meanwhile the district had gone on prosperously, and the 2000 of 1851 had multiplied into 5000.

Towards the close of this famous year of drought, the Board of Health, roused by the universal cry of distress, bethought them of their functions, and called in an engineer from a neighbouring town. In their long torpidity the coal industry had spread, coming nearer and nearer until it passed the village, and a great shaft was sunk at a point nearly a mile below it. The sinkers had not gone more than 20 or 30 fathoms when a spring of water was tapped, and a strong and continuous flow gushed forth, sometimes amounting to as much as 1000 gallons per minute. Heavy pumping was required, and it took months of arduous labour to "tub" back the flood, a sign, it was concluded, of the presence of a great subterranean current or reservoir extending along the axis of the valley. The water, though very hard, was brilliantly clear and palatable; and it was natural that this underground stream or reservoir should be looked upon as a likely source. Another possible source—possible in those days—was the strata below the flat "ings" or "holmes" bordering the river, it being known that everywhere in this flooded margin, clear water was met with a few feet below the surface—not, as most people seemed to think, stray water escaped from the river bed, but subsoil or bottom water lying at a level too low for it to flow off.

The idea of gravitation was dismissed, both catch-ground and reservoir sites being wanting within a practicable distance; and the scheme of an artificial catch-ground propounded seventeen years before by the inspector, was either forgotten or not deemed worth a second thought. The river itself, though inexhaustible in quantity, was the sewer of a million people, and therefore too foul and irreclaimable for any one but an enthusiastic patentee.

With the two or three underground sources placed before him, the engineer was not long in deciding, and he ended his investigation by recommending a river-side pumping scheme not unlike the systems of certain of the London companies. But apart from the doubtful quality of this source, the cost was too much for the ratepayers, and soon the fighting element, so strong in the district, asserted itself. An estimate of 10,000*l.* or 12,000*l.* was thought a trifle too extravagant for a commodity which up to that time had cost nothing to the rates; and nothing to the ratepayers, but the bills of the pump and cistern makers, and the well sinkers, with their refreshing items for repairs, besides a little matter in the way of water famines every dry summer, a goodly file of doctor's bills, and a fat increment to the bills of mortality. Such an estimate could not be "tholed." So the ratepayers soon woke up, organised, and met and denounced the scheme incontinently.

The Board having made up their mind, met the opposition dexterously by acceding to the wish of the ratepapers for a competition—the latest form of democracy—and they advertised accordingly, offering to the engineering world a single premium for the best scheme. Three schemes were entered, two by the Board's engineer, which may be described as the one he recommended and the one he did not recommend; and one from an outsider, a young man, who having little to do just then, and his living to make, neither feared nor disdained to pit himself against bigger men; and, as a matter of course, the Board selected their own engineer's plans, generously exceeding their bond, however, and softening their refusal, by awarding a second premium to the stranger, who, they did not deny, had produced a sound scheme. The selected design went cautiously about its business, too cautiously perhaps; for it did not pin its faith either upon the colliery or the river-side water, but with more indecision than judgment, steered a course between the two so as to catch both, if possible; the site of well being fixed at the point where the level alluvium met the gentle slope of the ridge a few chains from the river. A pumping station was to be erected at the well, and a service reservoir for a week's supply was to crown the nearest hill.

(To be continued.)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(FROM OUR NEW YORK CORRESPONDENT.)

THE seventh annual meeting of the American Society of Mechanical Engineers was held in New York City, November 30 to December 3, 1886. It had been the desire of many members that a meeting of the Society should be held in Providence, R.I., but the winter meetings are largely attended, and we really did not want to crowd this little State of Rhode Island, although the whispers which reached the Council told of a spring meeting to be held there, when Rocky Point would be open. This settled the matter beyond all peradventure to every one who had ever been to Rocky Point, for the fame of this resort is so great that your correspondent during 1862, sitting with a number of officers in Fort Wagner, was deeply commiserated because he had never been there, and was told that if he should be killed by the next rebel shell, his whole life would be a failure. Having been to this resort several times since those days, he accepts the truth of the above statement.

As the President of the Society was too ill to address the meeting, it was decided to have an address on the "Early Movement of Mechanics," by that veteran engineer, Mr. Horatio Allen, whose name is as well known in Europe as in America. The title of Mr. Allen's remarks might in these days of agitation be misleading, but it was not a labour tract, nor did it relate especially to the habits of that class; indeed they have never been accused of any "early movements," except about "quitting time," and the promptest thing a mechanic does in this enlightened land is to send in his bill for services he claims to have rendered.

Mr. Allen's remarks referred to the early history of the steam engine, and his reminiscences of bygone days were remarkable and interesting. He claimed for this country that it did not import its railroads ready made from England as had been popularly supposed, but had contributed its share in their building and development. In the case of your Liverpool and Manchester Railway, two of the most prominent engineers of that time advocated the use of stationary engines and ropes for motive power, and its projectors offered 500*l.* to any one constructing a locomotive which would haul three times its weight ten miles per hour. The result was the famous "Rocket." Shortly after Mr. Allen came to England, examined, purchased, and shipped three locomotives to this country.

On speaking of marine engines, Mr. Allen said, that in the early stages there was a distrust of a vessel having a single engine, so that when the South Carolina, built to this type by the Novelty Iron Works, was sent to Charleston, S.C., many predicted she would never turn Cape Hatteras, and would perish with all hands at sea. In spite, however, of the single engine, she arrived in safety, although one day late, having been compelled to put to sea by a storm. This delay caused all the prognosticators of evil to rise up like Mr. Wiggins, of Canada, and say, "I told you so,' whenever after twenty failures he happens by accident to make a true forecast of the weather. Mr. Allen claimed also to be one of the first investigators in the problem of using steam expansively, and to have tried it on the Erie Railroad; not meeting with much encouragement here, he next rigged up an expansion gear on the Novelty Works engine. Some time later the link motion was brought over from England, and did not differ greatly from his invention. Mr. Allen next spoke of his efforts to put a surface condenser in the British Queen forty years ago, and how Mr. Hamilton, of the Soho Works, advised against it. He had experienced great difficulty in being allowed to put an independent circulating pump on a steamer, and all this through the defective manner in which his experimental pump had been put in by the workmen, so that he made the following as his experience: "All we do depends on the experience of those in whose hands we place our work," hence, he argued, that the great need of the present day was a higher order of intelligence in young men who came into the shops, and here is just where

DREDGING MACHINERY.

(*For Description, see Page 6.*)

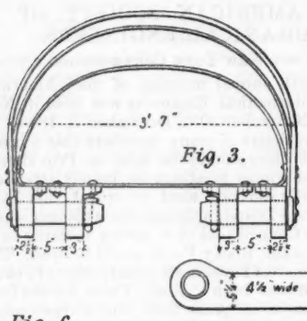


Fig. 3.

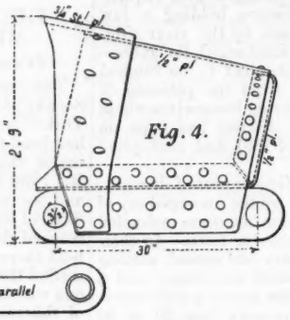
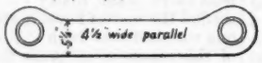


Fig. 4.



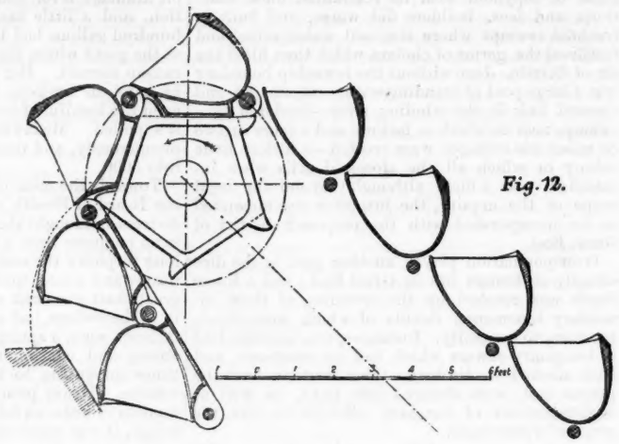


Fig. 12.

Fig. 6.

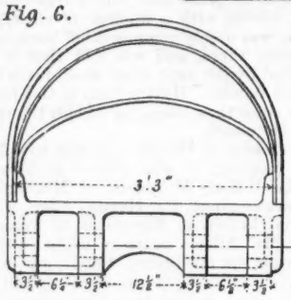
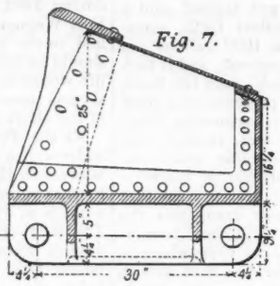


Fig. 7.



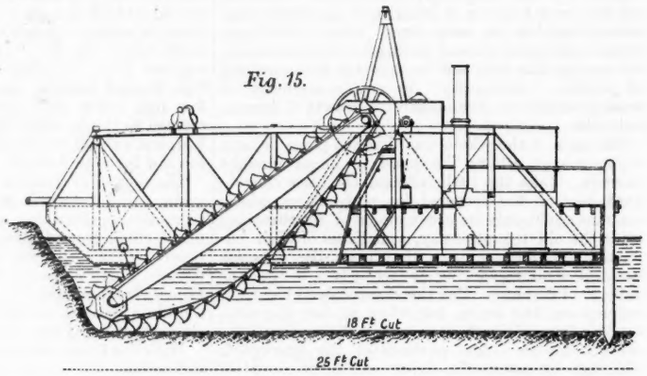


Fig. 15.

Fig. 8.

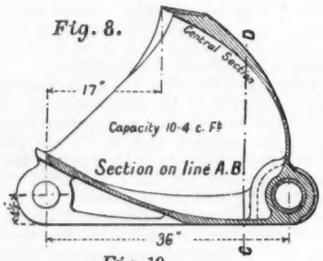


Fig. 9.

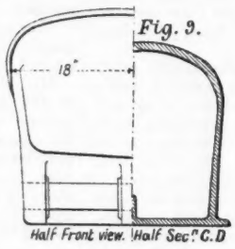


Fig. 10.

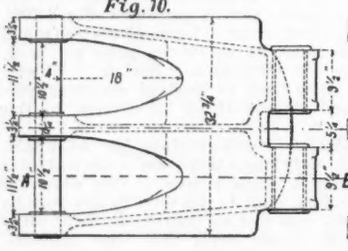
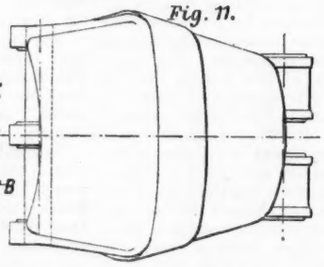


Fig. 11.



the trades unions come in for interference, and as the writer thinks do incalculable evil, first by limiting the number of apprentices, and secondly, by insisting that all shall be paid the same wages, and thus destroying all ambition. At the conclusion of Mr. Allen's remarks, he was warmly applauded and received a vote of thanks, after which the Society adjourned from science to supper, and from brain exercise to brain food.

REPORTS OF COMMITTEES.

The next morning the Society assembled for a business meeting and to hear papers. The financial condition was pronounced by the experts to be resting on a foundation in stable equilibrium, and the Committee to Secure the Appointment of the United States Commission to Test Materials having reported their efforts to be unavailing, were, at their own request, discharged.

In regard to "Standard Pipe and Pipe Threads," the report was all that could be desired. The Committee had a joint session with one from the Pipe Manufacturers' Association, and one from the Cast-Iron Fittings Association, and it was resolved that a common standard should be adopted, and such action should first proceed from the pipe manufacturers. Accordingly that body, meeting at Pittsburg October 27, 1886, had adopted the Briggs standard of gauges, and requested all manufacturers who had from any cause drifted away from this to have such corrections made as would enable them to conform to it. It was then decided in accepting the Committee's report, that a table setting forth the Briggs standard should be incorporated. The importance of this matter called forth considerable discussion, and Mr. George M. Bond, of the Pratt and Whitney Company, whose able paper on the subject has been so well received, made some statements regarding England, where he claimed there seemed to be no standard; and this brought up the suggestion that there should be a uniform standard for all parts of the world, and with this view the Committee was continued. It is to be hoped that your country will hear from them, and it will be no small credit to our society, but seven years old, if they inaugurate and successfully establish this long-needed uniformity. Dr. Cheney, of London, Warden of the British Standards, has obtained a copy of the report of the Committee, and has expressed his appreciation of their work and his desire to co-operate. To show what difficulties are encountered at present, one member stated he had sent machinery to Australia and left one end of pipe without thread to be cut for their fittings. At the annual meeting of the Cast Iron and Brass Fittings Association held in New York December 8, a resolution was passed indorsing the resolution of the Pipe Manufacturers' Association above referred to, and adopting the Briggs standard, to be carried into effect as soon as possible, which is another long step in the right direction.

As regards the Committee on Uniform Methods of Tests, the advantage of uniformity in this matter was urged, although the Committee had not yet achieved much success. Still they were at work. This, too, is a most important matter, and one that engineers cannot too strongly urge on manufacturers of material.

Now came the result of the election for the ensuing year, and it was as follows: President, George H. Babcock; vice-presidents, Joseph Morgan, Charles T. Porter, and H. S. Smith; treasurer, W. H. Wiley; managers, F. G. Coggin, John T. Hawkins, and T. R. Morgan, Sen.

FRICTION IN TOOTHED GEARING.

The real business of the session now commenced, and the first paper was from your side of the water, being "Friction in Toothed Gearing," by Professor F. Reauleaux, of Berlin. The writer has examined it with great care in hopes of being able to make an abstract to give such of your readers as did not care to read the entire paper a fair idea of the contents and of the line which the author had followed in his investigation, but has been obliged to abandon it. It is not an abstract matter, being a series of formulæ carefully worked out, showing the various features of the problems involved. It covered the friction of the teeth of spur wheels, but could be adapted to bevel wheels also. It was of a high order of mathematics, too high for the writer, whose courage gave out at the array of differentials, integrals, and subscript accents. Not understanding it, he unhesitatingly pronounces it of high excellence.

Professor Reauleaux's paper called forth consider-

able discussion, as several present did not agree with him. It brought forth also a desire to have large gear wheels interchangeable. But to understand the paper it must be studied carefully as a whole.

THE FRICTION OF NON-CONDENSING ENGINES.

The next paper was by Professor R. H. Thurston, entitled "The Friction of Non-Condensing Engines." The professor remarked that De Pambour's statement that the wasteful resistance of a steam engine consists of a constant quantity, the friction of the unloaded engine increased by some increasing function of added load, had been accepted as correct ever since its utterance. This statement the author intended to criticise. The first investigation was made in 1883 and 1884 in a straight-line engine, exhibited at the American Institute, and although the results were exact and satisfactory, he had checked them by a new series made in a similar engine, but from a different manufacturer. The engine was fitted with a pair of carefully standardised indicators and a ring, as shown in Figs. 1 and 2.

Cards were taken simultaneously from both ends of the cylinder, and readings from the brake at the same instant, the difference between the power shown by the diagrams and that indicated by the brake being the friction. The engine was making 230 revolutions, and the steam pressure was 90 lb.; the annexed Table shows the results.

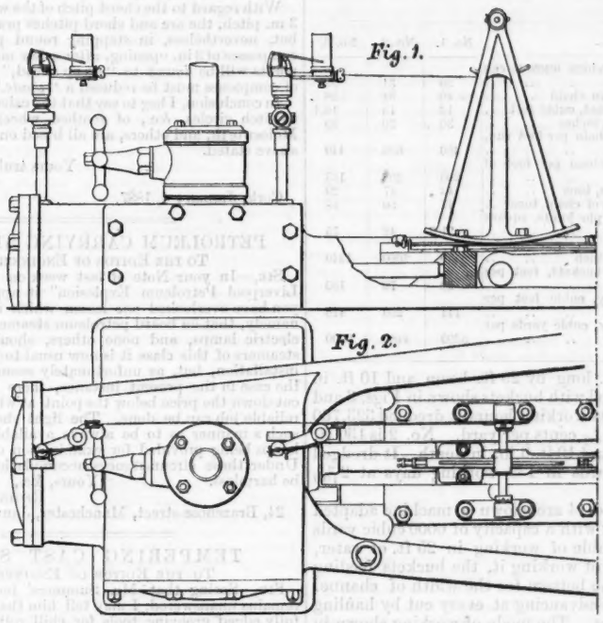


Fig. 1.

Fig. 2.

THURSTON'S INDICATOR GEAR.

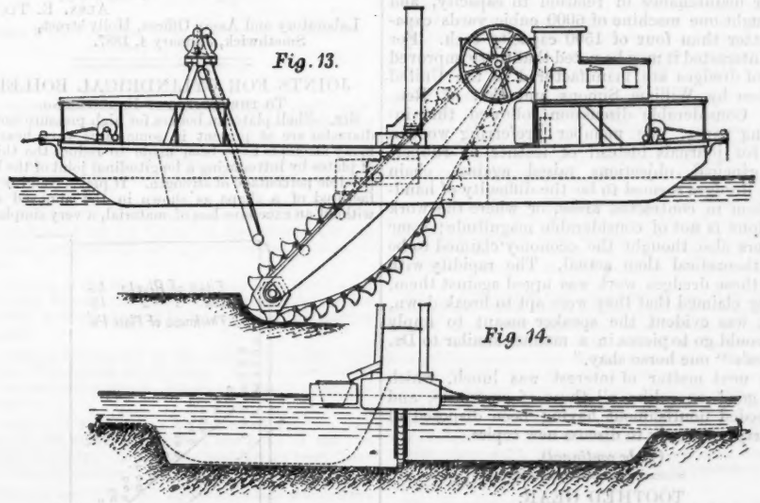


Fig. 13.

Fig. 14.

DREDGING MACHINERY.

Number of Card.	Revolutions.	Steam Pressure.	Brake Horse-Power.	Indicated Horse-Power.	Difference.	Friction per Cent.
		lb.				
1	232	50	4.06	7.41	3.35	45
2	229	65	4.98	7.58	2.60	34
3	230	63	6.00	10.00	4.00	40
4	230	69	7.00	10.27	3.29	32
5	230	73	8.10	11.75	3.65	32
6	230	77	9.00	12.70	3.70	29
7	230	75	10.00	14.02	4.02	28
8	230	80	11.00	14.78	3.78	25.5
9	230	80	12.00	15.17	3.17	21
10	230	85	13.00	15.96	2.96	18.5
11	230	75	14.00	16.86	2.86	17
12	230	70	15.00	17.80	2.80	15.75
13	231	72	20.1	22.07	2.06	9
14	230	75	25.00	28.31	3.36	11.75
15	229	60	29.55	33.04	3.16	9.5
16	229	58	34.86	37.20	2.34	6.3
17	229	70	39.85	43.04	3.19	7.4
18	230	85	45.00	47.79	2.75	5.8
19	230	90	50.00	52.60	2.60	4.9
20	230	85	55.00	57.54	2.54	4.4

It appears from the Table that the friction varies somewhat with varying steam pressures, although in this case it might have been due to errors of observation. It is, however, apparent that De Pambour's law does not hold true. The speaker considered it more correct to say, the friction of a non-condensing engine of this class is constant and independent of the power exerted. In the engine considered (it was 35 to 40 horse-power) the friction was about 6 per cent., or less than half that of De Pambour.

A second series of experiments were made this year at Cornell University, and confirmed the previous opinion regarding the friction being nearly constant under all loads, as may be seen in the following Table:

1. Number of Card.	2. Revolutions per Minute.	3. Steam Pressure.	4. Brake Power. H.P.	5. Indicated H.P. per Card.	6. Differential Friction. H.P.	7. Mean Frictional Pressure.	8. Friction per Cent.
1	282	19	0	2.26	2.26	3.70	100
2	288	65	4.87	8.43	3.56	5.56	42
3	286	66	7.61	10.95	3.33	5.25	30
4	284	65	10.30	12.93	2.89	4.13	20
5	285	71	13.10	15.99	2.61	4.25	18
6	284	76	15.80	18.79	2.99	4.71	16
7	284	74	18.55	20.73	2.65	4.18	12
8	280	67	21.00	23.73	2.73	4.37	11
9	279	65	23.61	25.95	2.33	3.73	9
10	280	75	26.39	29.05	2.36	5.88	11
11	280	72	29.03	32.22	3.19	5.15	10

As it was remarked that the engine friction varied at constant load and speed with variation of steam pressure, a new series of experiments were made to ascertain if this might not be due to some other cause not discovered as yet, but they showed conclusively the truth of the statement. The following conclusions were then drawn by the author as the result of his experiments.

1. The friction of the non-condensing engine, of the class here described, is sensibly constant at any given speed, at all loads, and is at different speeds entirely independent of the magnitude of the load.

2. The friction of engines, of the type described, is variable with variation of speed of engine, increasing as speed increases, in some ratio as yet undetermined, but probably different with every engine, and, for the same engine, with every change of conditions of operation.

3. The friction of engines increases with increase of steam pressure, in the case of the class here referred to, in a probably similarly variable manner with that observed with alteration of speed, neither method of variation being capable of representation by any convenient algebraic expression.

4. The total resistance measured at the piston of the engine is composed of two parts, the one sensibly constant at the working speed, the other variable with external load.

Whether these results will be obtained with condensing engines is problematical; the laws then may be entirely different.

The Professor's conclusions were confirmed by tests made on a Westinghouse engine running 350 revolutions, and explained by Mr. G. H. Barrus. When loaded to 44.1 horse-power, the engine friction was equal to 6.1 horse-power, and with 34.6 horse-power the friction was equal to 6.3 horse-power. Mr. Barrus also gave the following results from a Corliss engine:

—	Indicated Horse-Power.	Brake Horse-Power.	Difference.
Unloaded ..	12.2	0	12.2
Loaded ..	72.8	60.4	12.4
	101.9	89.7	12.8
	109.5	106.0	13.9
	133.3	121.5	11.8
	145.4	133.0	12.4
	148.4	144.8	13.6

Professor Lanza, of Massachusetts Institute of Technology, also had found the views of Professor Thurston confirmed in his tests, while Mr. Wolff thought that engineers in general considered friction independent of the load, alleging as proof the

practice of taking indicator cards with the engine unloaded and then with a full load, and considering the difference as the load of the engine. Mr. Kent also discussed the question, considering the friction of the piston rings as one of the main items in the total friction of the engine.

DREDGING MACHINERY.

The next paper was by Mr. A. Wells Robinson on "Dredging Machinery," and was an argument in favour of the chain bucket or elevator system, as against the more prevalent type used here of boom dredges. The author should certainly meet with favour in your country, for he fortified his position with the statement that nearly all the dredges of Great Britain were of the bucket kind, which he characterised as being of the most substantial character and excellently adapted to their purpose.

In 1882 five of the chain bucket dredges belonging to the Clyde Trustees excavated 1,309,300 cubic yards of mud, some parts being clay, blasted rock, and boulders, at a cost of 66,800 dols., or 5.1 cents per cubic yard. Of this cost 44 per cent. was wages and 56 per cent. repairs. The strong point in favour of endless chain machines lies in their continuous action, and where the work is sufficient this form can deal with large quantities at a rapid rate, cutting a perfectly level bottom. The digging action, moreover, of chain buckets takes place in a manner calculated to apply the power to the best advantage, the cutting edges entering horizontally and curving upwards on a short radius, thus filling the buckets and retaining their contents. They are further able to take off light cuts over large areas.

The entire apparatus is in equilibrium as to the weight of the working parts, and the power is used only to lift material and to overcome the digging and frictional resistances, in contrast to the power lost at each stroke in the boom dredge in lifting the bucket and its attachments.

This loss is a serious one in deep water. A comparison of indicator cards of the two machines showed that 226,000 to 353,000 foot-pounds was required per cubic yard of material in the chain bucket dredge, while in the boom dredge it was nearly three times as much, both machines working in tolerably soft material, and in 32 ft. of water. The author thought, however, double that amount was about the average. He then proceeded to discuss the details of construction, specifying a chain consisting of stout wrought-iron links connected by joint pins, with the shell or body of the bucket rivetted to every alternate set of links, as shown in Figs. 3, 4, and 5 on page 4.

There were usually four links under and forming part of a bucket and the intermediate connecting links, the eyes of which are bushed with steel. There was considerable wear in them on account of the small and roughly-fitted bearing surfaces of the joints, and from the grinding action of sand and water; about six months' hard usage, he thought, would send these buckets to the repair shop, as they do not possess much stiffness, and the springing of the plates loosens the rivets.

A better form was where the four links of the bucket were made in the connected form of a single steel casting to which the top or body is rivetted (see Figs. 6 and 7). In this arrangement much of the difficulty caused by the shaking loose of rivetted parts is obviated.

A preferable method was to make the entire bucket of a single steel casting, but this did not obviate the destructive and costly wear of the bushes, pins and links, but by distributing the wear over a larger surface it is reduced to a minimum. The form shown in Figs. 8, 9, 10, 11, and 12, is believed to combine lightness, strength, capacity, and durability to a degree not hitherto reached.

Durability of the pin connections is obtained by providing large wearing surfaces, from which sand and grit are excluded by a special form of self-expanding packing ring. The wearing surfaces are lubricated by positive feed from a grease chamber in the bore of the tubular joint pin, which can be fed from outside. The bucket is composed of cast steel in one piece, with removable steel cutting edges and wearing surfaces proportioned so that the safe working strength is in excess of the maximum tension that can be applied. These buckets are shown in position upon the upper or driving tumbler, and are coupled directly to each other, thus avoiding intermediate links.

They are adapted to work on an improved driving tumbler in which the rear of the bucket is supported by projections forming an extension of the driving face of the tumbler; by this method all the wear occurring between the tumbler faces and the links is avoided, the whole apparatus is much lighter, and the principal stress is the tension of the chain. The form of bucket further permits an enormous tensile strain without being obliged to unduly increase the weight in order to resist it, for the whole back, sides, and bottom of the bucket form a link of great strength. The following Table shows a comparison between dredgers having the three forms of buckets considered:

—	No. 1.	No. 2.	No. 3.
Maximum depth to which buckets can work, feet	30	31	30
Number of buckets in chain	40	34	46
Capacity of each bucket, cubic feet	12	15	10.4
Pitch of each bucket, inches	30	30	39
Weight of bucket chain per foot run, pounds	480	623	440
Weight of bucket chain per foot of capacity, pounds	200	208	138
Total weight of chain, tons	43	47	29
Safe working tension of chain, tons	47	50	45
Wearing surface of pin joints, square inches	31.5	42	75
Maximum pressure on pin joints, pounds per square inch	5340	2660	1340
Ordinary speed of buckets, feet per minute	60	70	130
Discharging capacity, cubic feet per minute	144	200	416
Discharging capacity, cubic yards per day of ten hours	3200	4400	9200

No 1 is 161 ft. long by 29 ft. beam and 10 ft. in depth, and is fitted with buckets shown in Figs. 3 and 11. During 2694 working hours it dredged 323,760 cubic yards at $3\frac{8}{100}$ cents per yard. No. 2 is 130 ft. by 32 ft. beam, and 10 ft. 6 in. in depth. It dredged 409,500 cubic yards in 139 working days at $2\frac{27}{100}$ cents per yard.

In Figs. 13 and 14 are shown a machine adapted for channel work with a capacity of 6000 cubic yards per day and capable of working in 25 ft. of water, also the method of working it, the buckets feeding sideways over the bottom for the width of channel to be made, and advancing at every cut by hauling in the bow chains. The mode of working shown in Fig. 15 is where a speed anchor post is used at the stern for mooring the hull, and the buckets at the front end take a radial cut about the speed as a centre.

The author called attention to the fact that consideration must be had not alone for the first cost, but for maintenance in relation to capacity, and he thought one machine of 6000 cubic yards capacity better than four of 1500 capacity each. For those interested it may be noted that these improved forms of dredges are manufactured in the United Kingdom by William Simons and Co., of Renfrew. Considerable discussion followed this interesting paper, one member preferring wooden boxes for journals instead of leather or rubber. The principal objections raised against chain bucket dredges seemed to be the difficulty of handling them in contracted areas, or where the work to be done is not of considerable magnitude; some members also thought the economy claimed to be more theoretical than actual. The rapidity with which these dredges work was urged against them, it being claimed that they were apt to break down, and it was evident the speaker meant to imply they would go to pieces in a manner similar to Dr. Holmes's "one horse shay."

The next matter of interest was lunch, which was a good one, like all those of engineers, and the needed nourishment having been disposed of the party was ready to discuss new topics.

(To be continued).

TOOTHED GEAR.

To the Editor of Engineering.

SIR,—Your foot-note to letter of "Discipulus" in last week's ENGINEERING contains in a "nutshell" the information he requires. But a few of your readers may have mixed ideas as regards confounding the *arc pitch* with the "chord pitch." I beg to be excused for enlarging a little on the subject.

1. The pitch circles of a pair of wheels are the circles on which the wheels roll on each other.

2. The arc pitch × number of teeth = circumference of pitch circle.

3. $\frac{\text{Arc pitch} \times \text{number of teeth}}{3.1416}$ = diameter of pitch circle.

4. $\frac{\text{Diameter of pitch circle}}{\text{number of teeth}} \times 3.1416 =$ "arc" pitch.

5. $\frac{\text{Diameter of pitch circle}}{\text{arc pitch}} \times 3.1416 =$ number of teeth.

Now the length of an arc of a circle being greater than that of its chord, it necessarily follows that the arc pitch when developed will be greater than the chord pitch.

Taking the very extreme case of the pinion of 8, 3 in. pitch, we have $8 \times 3 =$ circumference of pitch circle.

$\therefore \frac{24}{3.1416} = 7.6394 = 7\frac{8}{13} + \frac{1}{34}$ nearly = diameter of pitch circle.

Now if we describe this pitch circle, and divide it into 8 parts, we find the *chord* pitch equals only $2\frac{11}{16}$ in., although the *arc pitch* = 3 in.! If we should require to have the *chord* pitch = 3 in., we should increase the radius of pitch circle by nearly $\frac{1}{8}$ in. This we must not do, for the ratio of velocities would be vitiated. The former chord pitch is the correct one, *i.e.*, the $2\frac{11}{16}$ in.

With regard to the chord pitch of the wheel of 120 teeth, 3 in. pitch, the arc and chord pitches practically coincide, but, nevertheless, in stepping round pitch circle with compasses of 3 in. opening, after a few multiples the pitch points will be found to "creep ahead," and the opening of compasses must be reduced a "*shade*."

In conclusion, I beg to say that the calculations referring to pitch circles, &c., of toothed wheels of Templeton, Molesworth, and others, are all based on the rules I have above stated.

Yours truly,
R. HARTLAND.

Cork, January 4, 1887.

PETROLEUM CARRYING STEAMERS.

To the Editor of Engineering.

SIR,—In your Note of last week on "Lessons of the Liverpool Petroleum Explosion" it appears to me that you have overlooked one lesson which is of importance, namely, that on board petroleum steamers incandescence electric lamps, and none others, should be used. In steamers of this class it is now usual to put in an electric installation, but, as unfortunately seems to have been the case in the present instance, there is a tendency to cut down the price below the point at which a thoroughly reliable job can be done. The light should be fitted in such a manner as to be always available, suitable hand lamps being provided for examination of the tanks, &c. Under these circumstances accumulations of gas would be harmless.

Yours, &c.,
REGINALD A. SMITH.

24, Brazenose-street, Manchester, January 4, 1887.

TEMPERING CAST STEEL.

To the Editor of Engineering.

SIR,—Seeing that Mr. Summers' inquiry (page 642) remains unanswered, I may tell him that I have successfully edged grooving tools for chill rolls by dipping the actual cutting portion in mercury. No more of the steel than is actually necessary should be dipped, as, while imparting an intense hardness, it naturally makes the body of the tool extremely brittle.

I think, if Mr. Summers tries this with best tungsten or chromium steel, he will obtain the result he wants; both these yield a far harder temper than a carbon steel.

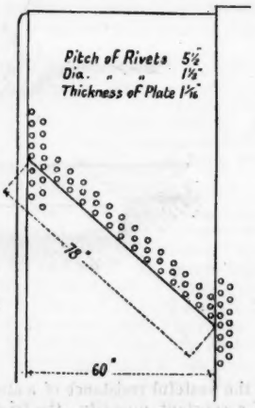
Yours truly,
ALEX. E. TUCKER.

Laboratory and Assay Offices, Holly-street, Smethwick, January 4, 1887.

JOINTS FOR CYLINDRICAL BOILERS.

To the Editor of Engineering.

SIR,—Shell plates in boilers for high pressure and large diameter are at present in some cases very heavy, and many attempts have been made to reduce the thickness of plates by introducing a longitudinal joint of the highest possible percentage of strength. If plates could be manufactured of a shape as shown in the annexed sketch, without an excessive loss of material, a very simple longitudinal joint of high percentage of strength as compared with the solid plate, may be obtained. Compared with the double butt strap joint this diagonal joint has some advantages: 1. Ten to fifteen per cent. more strength may be gained, and consequently the same reduction of weight of the shell. 2. A closer pitch of rivets is attained. 3. This joint is more flexible across the plates than other joints, and saves a great deal of labour.



Yours truly,
D. WULFF.

Bremen, December 31, 1886.

CENTRIFUGAL PUMPING MACHINERY.

TO THE EDITOR OF ENGINEERING.

SIR,—Our attention has been directed to the engravings of a portable centrifugal pumping engine displayed on page 644 of your issue of the 24th ultimo, and we beg that you will allow us space in your next number to say that the mode adopted in the said machine of attaching the pump to the engine framing is a direct infringement of the Letters Patent granted to us in Great Britain, the United States, and other countries. In fact, the entire pump appears to be a faithful copy of ours (the "Invincible") in every detail, and we are taking the necessary steps to defend our rights.

We are the last persons to desire to deprive Mr. Webber of whatever honour may be due to him in mounting one of our pumps and a Westinghouse engine on a four-wheel carriage, but we must say, in reference to this case, and in all others where manufacturers take upon themselves the task of enlightening their contemporaries with new designs, that such designs should, we think, at least be their own and not those of other manufacturers.

It may not be uninteresting to a section of your readers to know how the Lawrence Machine Shop obtained its information concerning our pumps. About two years since Mr. S. Webber, a member of the firm, came to us ostensibly for the purpose of making arrangements to represent us in the United States for the sale of the "Invincible" pumps, and mentioned the names of several gentlemen in America to whom we were personally known. We were disposed to entertain this proposal, and with that object in view we gave Mr. Webber very full information.

The result of our interviews with this gentleman has been that the Lawrence Machine Shop now issues catalogues of "Improved Centrifugal Pumping Machinery constructed on the Gwynne system, which has been proved the most perfect and economical in the world" (we quote the title page of their catalogue), and without any consultation with or authority from us.

Yours faithfully,
J. AND H. GWYNNE.

89, Cannon-street, London, E.C., January 5, 1887.

STEAM STEERING GEAR.

TO THE EDITOR OF ENGINEERING.

SIR,—In the last number of ENGINEERING we observe illustrations of steam steering gear designed by Mr. R. Ziese, and regarding which we think it only justice to ourselves to state that it is very much the same as that patented by us in 1882, and manufactured by us since that time.

The parts which we particularly refer to are the special form of driving wheel which acts as a wormwheel when steam power is applied, and as a spurwheel when hand power is used, and also the arrangement of gearing in such a way that there is no motion of controlling valve when steering by hand.

All our combined steam and hand steering gear is so arranged that it is not necessary to turn off the steam should a hurried order be given to change from steam to hand steering.

We are, yours respectfully,
JOHN HASTIE AND CO.

Kilblain Engine Works, Nicholson-street, Greenock, January 4, 1887.

MISCELLANEA.

TELEPHONIC trials made last week with the newly established wires between Brussels and Paris were perfectly successful.

Captain Lord C. T. M. D. Scott, C.B., aide-de-camp to the Queen, is to be the new captain of the Steam Reserve at Chatham Dockyard.

Baron Sadoine, lately managing director of the Cockerill Company, has set out for China *vid* Marseilles. Certain commercial undertakings are to be promoted by him in the East.

The piercing of the Suram tunnel has been found such an extremely difficult undertaking that the Russians are now talking of abandoning it in favour of a line turning the heights.

The death is announced of Mr. Dirks, principal engineer of the Waterstaat in Holland. He was considered one of the first authorities in Europe on harbour and canal construction.

The number of applications for patents during the past year was 17,162, which puts 1886 at the head of the list by a slight majority. In 1884, the next largest year, there were 17,110 applications.

On Monday one of the two belted ironclads which have been built at Stettin by the Vulcan Company for the Chinese Government was launched. The new vessel received the name of King-Quen.

At the last meeting of the German Cement Makers' Association, held in Berlin, it was stated that the export trade in German cement to Australia, which had become considerable, had been seriously injured by the adulteration of German cement.

In consequence of the necessity for imparting a more thorough mathematical and scientific training to the engineer students on board the Marlborough at Portsmouth, Mr. Worthington, a graduate of Cambridge, has been appointed chief master of the school.

It is stated that the Spanish Minister of Marine has decided to push forward the preparation of details in connection with the new fleet, in order that the complete plans and estimates may be ready before the commencement of the financial year beginning on July 1 next.

The Chicago *Railway Age* states that 8010 miles of new railway were laid in the United States in 1886, chiefly in the Western States. The cost of the new lines is estimated at 160,000,000 dols. It is believed that still greater activity will be shown during the present year.

The annual number of parcels circulating through the post, commencing in August, 1883, at about 18,000,000, was, in the first complete year of the calendar, 1884, 22,000,000, and, in 1885, nearly 26,000,000. But if appearances may be trusted it will reach something like 35,000,000 last year.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended December 26, amounted, on 15,386¾ miles, to 1,147,954*l.*, and for the corresponding period of 1885, on 15,244 miles, to 1,144,258*l.*, an increase of 142¾ miles, or 0.9 per cent., and an increase of 3696*l.*, or 0.3 per cent.

The Northallerton urban sanitary authority, at an adjourned meeting held on the 29th inst., appointed Mr. A. M. Fowler, civil engineer, of Manchester, engineer for the preparation of a scheme for the supplying of the town with water. There were seventy-two applicants.

An agreement has been arrived at between the Belgian and German ironmasters that tenders for rails shall no longer be made by Germans in Belgium or by Belgians in Germany. Negotiations are proceeding with the English ironmasters to induce them to adhere to the agreement.

The Nordenfelt submarine torpedo boat made her first run last week on the Golden Horn, remaining at the surface to test the engines and steering gear. She is reported to have showed great speed and handiness, and the trial was considered satisfactory. Next week submarine trials are to be made in the open sea.

The Admiralty have accepted the tender of Messrs. Maudslay, Sons, and Field, of London, for the machinery of the three torpedo gun vessels, Grasshopper, Sandfly, and Spider, of which two will be built at Devonport and the other at Sheerness. The engines are to be triple-expansive and of 3000 indicated horse-power.

A collision occurred on Tuesday morning at Trinity-street station, Bolton, through the dense fog which prevailed. The 9 o'clock train from Manchester to Blackburn was standing in the station when a train from Manchester to Blackpool arrived, and the driver being unable to see the front train, ran into it. The passengers were severely shaken.

The second-class steam cruiser Thames, a vessel of the Amphion class just built, made her contractors' trial of her engines on Tuesday. The following results were obtained: Draught of water, forward, 13 ft. 5 in.; aft, 17 ft. 3 in.; steam in boilers, 97 lb.; revolutions of engines, starboard, 108; port, 110; total indicated horse-power, starboard, 2166; port, 2329; speed, 17 knots.

An appendix to the report of the Chief Registrar of Friendly Societies for 1885 furnishes a list of 207 trade unions in England, together with details of their organisation. It appears that the oldest union which is still in active existence is the Steam Engine Makers' Society, which has its head-quarters at Manchester, and was established in 1824. Then come the General Union of Operative Carpenters and Joiners, started at Liverpool in 1827, and the United Society of Boilermakers and Iron Shipbuilders of Newcastle-upon-Tyne, originated in 1834.

The American Iron and Steel Association reports the American pig iron manufacture for the last year to have reached 5,600,000 tons, or 1,556,000 tons more than in 1885; that of Bessemer ingots 2,000,000 tons, an increase of 351,000 tons, and that of Bessemer rails 1,500,000 tons, an increase of 530,000 tons. These are the heaviest annual output ever reported. The iron ore produced in the country amounted to 10,000,000 tons; and 1,000,000 tons were imported. The iron and steel imports during 1886 were much heavier than during 1885, the excess being 1,000,000 tons. The large increase in railroad building has caused the main demand for more iron and steel.

Mr. R. Feldtmann and Co.'s annual report on the iron trade of the West Cumberland and Barrow-in-Furness district states that, the total stock estimated to be in maker's hands is 112,668 tons, and adding the iron in the four public stores of the district the total is 350,700 tons, against 368,600 tons this time last year. The make of hematite during the year was 1,229,000 tons, against 1,219,300 tons. The present stock is estimated to be only about equal to 100 days' consumption at the present rate. The foreign shipments of hematite pig and steel rails and blooms show large increases for the year, and there has also been a moderate increase in the shipments of these articles coastwise.

The Russian Government has concluded an arrangement with the firm of H. Hersent and Co., of Paris, for the raising of a sum of 25,000,000 roubles, gold, in order to construct the Perecop Canal, in the Crimea. The canal will establish a direct route between the Don, the Black Sea, and the Sea of Azoff, and three lines of rail—namely, the Knosnoff-Voronej, the Kursk-Charkoff, Azoff, Don or Mariopol line, and the Losoff-Sebastopol, Charkoff-Nicolaieff line will be brought into junction with it. The strategical importance of the canal will be considerable; but it will also enable the Russians to bring the coal and coke of the Don collieries to the Black Sea ports and undersell the English coal which at present enjoys almost a monopoly in those ports and at Constantinople.

In speaking of the removal of the masts from the Impérieuse, to which we have already made reference, the *Times* says of this vessel: "As she lies in the repairing basin at Portsmouth her draught in her present condition is 20 ft. 8 in. forward and 24 ft. 10 in. aft, giving a mean immersion of 22 ft. 9 in. Although the authorised coal supply of the Impérieuse amounts to 400 tons, her bunker capacity, including the spaces for the stowage of patent fuel for purposes of defence, is equal to 1200 tons. Previous to sailing on her experimental cruise 850 tons were placed on board, which brought her down in the water to 26 ft. 6 in. forward and 27 ft. 6 in aft, a mean draught of 27 ft., or about 2 ft. beyond her originally designed water-line. Hence the difference between her present and past immersion is no less than 5 ft. 3 in. After all deductions are made, the advantage secured of taking out her masts will be great. Besides raising her armour belt and torpedo ports higher out of the water, the difference in her displacement will probably enable her to realise the 17 knots speed for which she was designed."

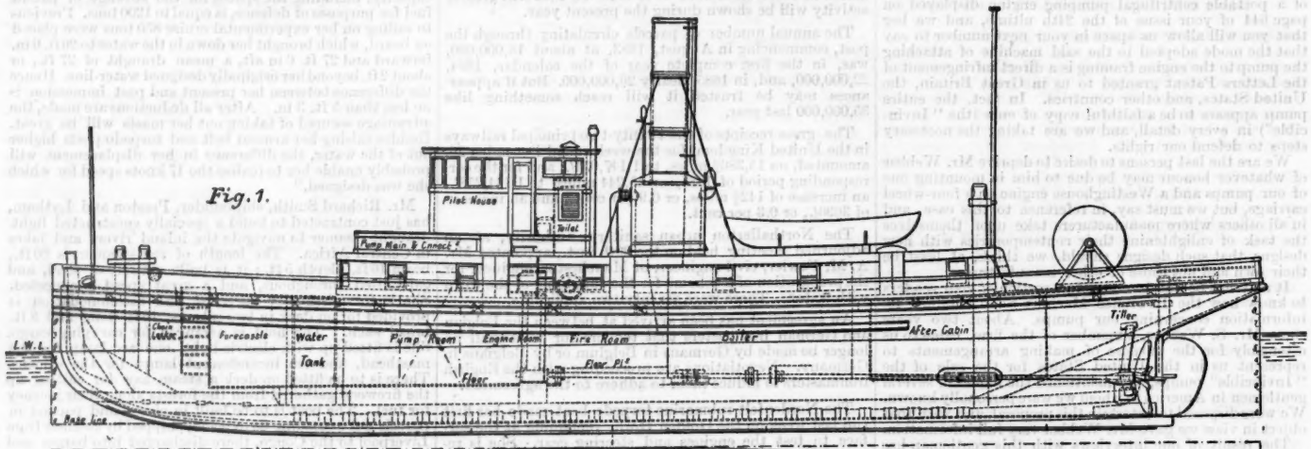
Mr. Richard Smith, shipbuilder, Preston and Lytham, has just contracted to build a specially constructed light-draught steamer to navigate the inland rivers and lakes in Central Africa. The length of the steamer is 90 ft., beam 16 ft., depth 5 ft.; it is built entirely of steel, and galvanised throughout, and a great speed is expected. She is for missionary purposes, and accommodation is provided for on deck in two saloons, 16 ft. long and 8 ft. broad each. The hold is arranged for carrying cargo. She is fitted up with electric light, one arc lamp for the masthead, and ten incandescent lamps for the saloons. There is to be fitted on deck a steam saw for cutting up the firewood gathered from the forests along their journey for fuel. The boat is to be built in pieces and packed in parcels not exceeding 65 lb. each, shipped by steamer from Liverpool to the Congo, there discharged into barges and taken a distance of 80 miles up the river, then carried on the heads of natives some 230 miles up to Stanley Pool. The total weight to be carried in this manner is 65 tons. This boat will be able to navigate some 5000 miles of the interior of Africa on rivers and lakes.

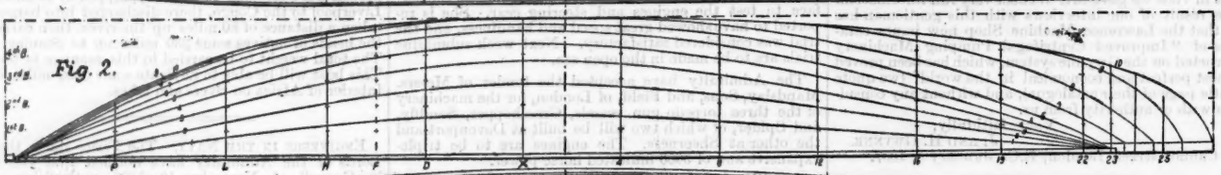
ENGINEERS IN THE NAVY.—The *Times* states that the Lords of the Admiralty have notified that the Order in Council of November 10, 1886, authorising certain alterations in the number of active engineer officers and engine-room artificers, rendered necessary by the changed conditions of the Navy, is to be enforced. Henceforth the chief inspectors of machinery are not to exceed five, and the inspectors of machinery seven, as at present. The number of fleet, staff, and chief engineers is not to exceed 250. Fleet and staff engineers are recent creations, and were made to get over the difficulty as to relative rank. As they perform chief engineers' duties all the same, the total shows an accession of 50 over the former establishment, and the difference is to be attained by an increase of not more than 10 chief engineers in each of the three years from June 1, 1886. The number of engineers and assistant engineers, which by previous orders had to be gradually reduced so as not to exceed 600, is now not to exceed 488, part of their duties falling upon chief engine-room artificers, whose strength is to be augmented to 250 by increments not exceeding 20 a year.

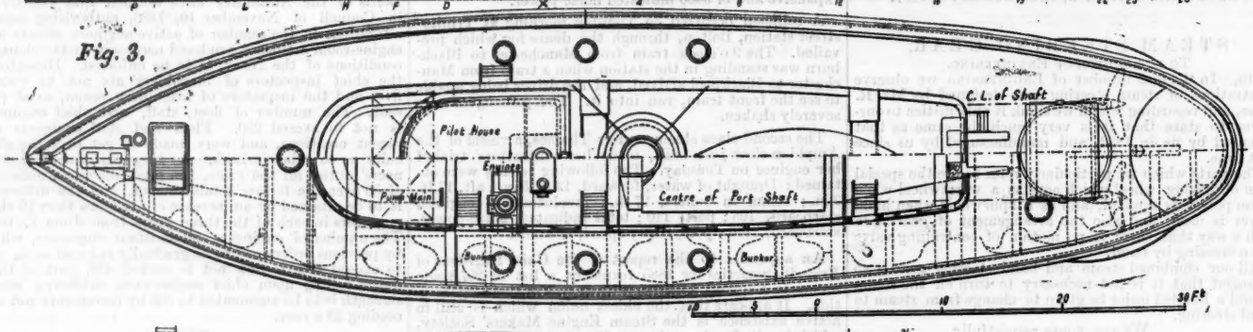
MOUNTING AND WORKING HEAVY GUNS.—One of the first fruits, says the *Times*, of the recent innovation whereby the supply of gun mountings for ships of war was taken from the War Department and placed in the hands of the Admiralty has been to break through the practical monopoly which has hitherto existed with respect to the mountings and gear for working the heavy armaments of our first-class battle ships. Up to the present time the whole of the hydraulic and turret and barbette fittings of modern men-of-war have been furnished from the Elswick Ordnance Works. Now other contractors are to be allowed a chance of competing with the firm of Sir William Armstrong, Mitchell, and Co. The contract for the hydraulic machinery, gun mountings, turret equipment, and the engines for rotating the turrets of the formidable sister battle ships, Nile and Trafalgar, of 11,940 tons, and each carrying four 13½ in. 67-ton breechloaders, the former building at Chatham and the latter at Portsmouth, has been given to Messrs. Maudslay, Sons, and Field. The progress of the Trafalgar continues to be satisfactory, and she is considerably ahead of the sister ship. Upwards of 2200 tons have been worked into the hull, and the first armour-plate has just been placed in position.

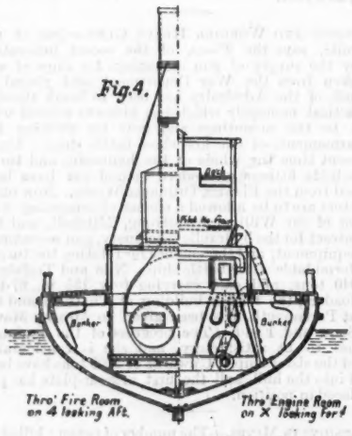
EXPLOSIONS IN MINES.—The number of persons killed by mining explosions in 1886 was 116. During the last 35 years there have only been three similar periods when the number killed was less. The first that took place this year was at Eaton Colliery, near Bristol, when eight men were killed. Naked lights were used by the men, and a quantity of gas being liberated it of course exploded. Naked lights or blasting also led to other explosions in which only two or three were killed. The greatest loss of life during the year took place on August 13, at the Bedford Colliery, Leigh, near Manchester, the killed numbering 38. There the Davy lamp, which has been stated by inspectors to be as dangerous as an open light, was the cause of the explosion. At the Bedminster Colliery, near Bristol, on September 10, ten men were killed by an explosion, naked lights being used in the mines. In the following month, October, 22 men were killed by an explosion at the Altofts Colliery, Normanton, in the West Riding. The cause was attributed to the coal dust. At the Elmore Colliery, in Durham, 28 lives were lost, but the inquiry has not yet been concluded. The last fatal explosion of the year took place on December 9 at the Reservoir Colliery, Leicestershire. A lighted candle was found in a portion of the workings where naked lights were prohibited; two miners were killed.

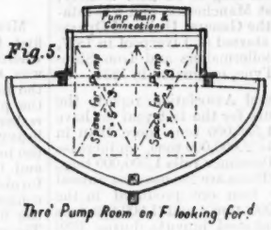
THE FIRE FLOAT "SETH LOW;" BROOKLYN FIRE DEPARTMENT.

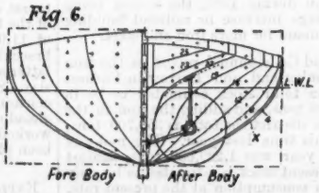


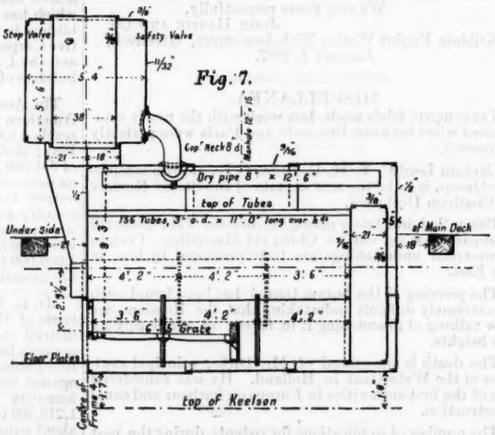












We illustrate on the present and opposite pages two types of American "fire floats" or floating fire engines as they are more usually called here. These boats have been dealt with in an interesting paper read by Mr. William Cowles, at the recent meeting of the American Society of Mechanical Engineers, and this paper we shall give in our next issue, together with further illustrations.

LITHOLINE.

Some time ago* we called attention to a disincrustant for steam boilers, manufactured by the Litholine Scale Prevention Company, of Park-road, Oldham. At that period it had attained very considerable success, which has since been increased by the continued evidence of its efficiency, and also by improvements introduced into its manufacture. In Galloway boilers, which are so common in Lancashire, litholine has proved most useful, and has removed coatings which hitherto had to be chipped off where accessible, and left to accumulate in other parts. Since its introduction in many works the Galloway tubes in the boilers have remained free from addition of scale, while that previously existing has peeled off. We have seen a specimen of scale an inch thick, and so hard that it took a polish of the lapidary's wheel, which had fallen off the plate spontaneously under the influence of litholine. The engineers of many of the boiler associations recommend the use of litholine to their clients.

An anhydrous form of the material is now manufactured, and has proved very convenient for shipping and transport, as the original liquid was very destructive to casks. It is specially adapted for water containing sulphate of lime or gypsum, which every one knows is particularly difficult to treat, and cannot be precipitated by Clark's and similar processes; those only deal with the carbonate. A special litholine is also manufactured for those boilers which supply steam for brewing, cooking, &c. This is guaranteed to have no ill effects on the food or the persons taking it, and its continued use in large public institutions is evidence that the claim is borne out in practice.

Of course litholine is not a universal remedy, like a patent pill, applicable to all sorts of water, and under all conditions. The manufacturers, therefore, undertake the analysis of water, and for the results obtained by the chemist they advise as to the steps to be followed for the prevention of scale. This is a most necessary arrangement, for it is the ignorant application of remedies, without a knowledge of the cause of the trouble, which brings discredit on boiler fluids.

* See Engineering, vol. xxxviii., p. 42.

THE LATE MR. W. E. RICH.

We much regret to record the death on the 22nd ult. of Mr. William Edmund Rich, member of the firm of Easton and Anderson, of Whitehall-place, London, and Erith, Kent. Mr. Rich came of an old Wiltshire family, his father being Mr. Edmund Rich, of Willesley, in that county; he was born on May 19, 1844, so that at the time of his death he was only in

FIRE FLOAT FOR CLEVELAND, U.S.A.

(*For Notice, see opposite Page.*)

Fig. 8.

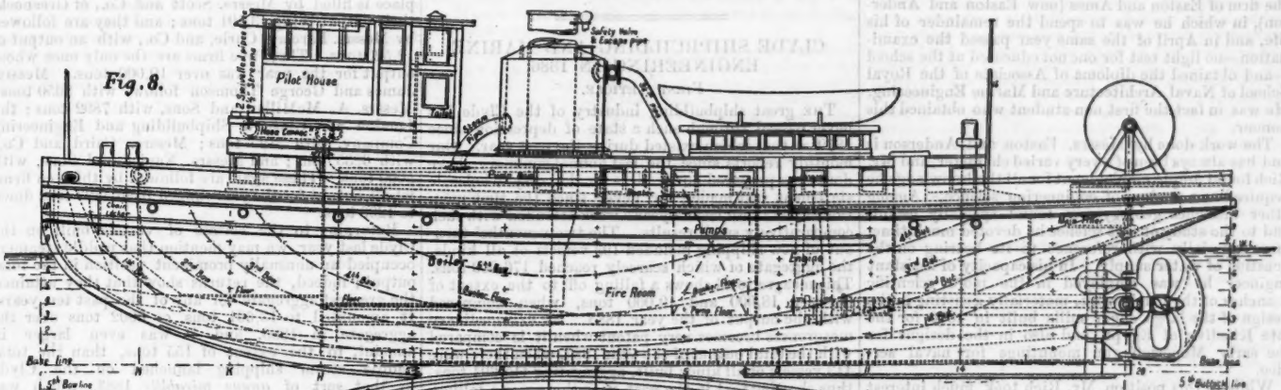


Fig. 9.

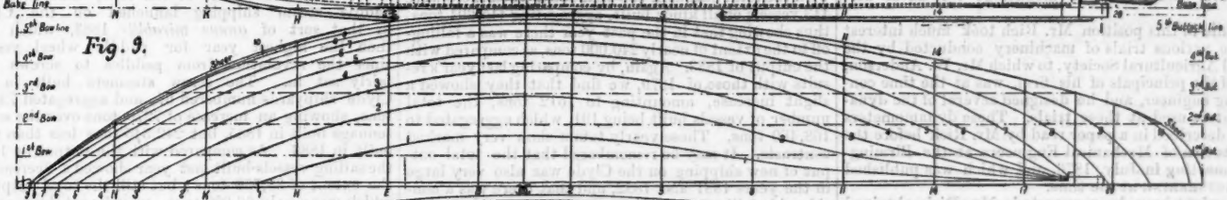


Fig. 10.

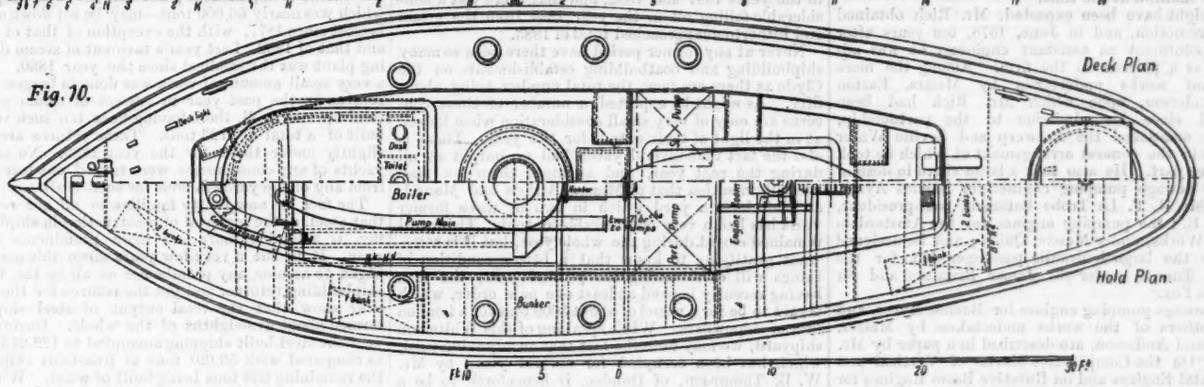


Fig. 12.

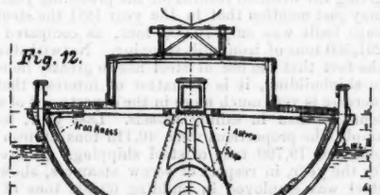


Fig. 13.

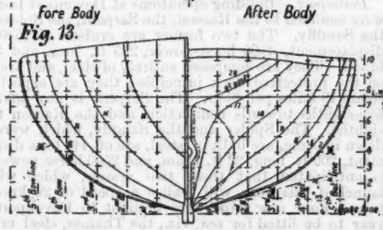
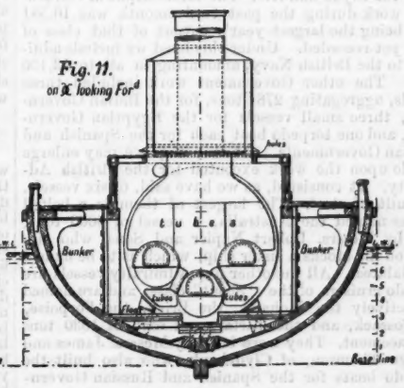


Fig. 11.
on B looking For^d



his forty-third year. His education was commenced in a private school at Chippenham, and continued at the Cheltenham Grammar School, which he entered in 1858.

At Cheltenham Mr. Rich displayed those qualities of earnestness and high ability which distinguished him through life, passing with honours in both cases the Oxford middle and senior examinations; and his mathematical master, Mr. Jefferys, writing after a lapse of twenty-five years, says, "I had known Mr. Rich from his boyhood onwards and felt a personal interest and pride in his professional eminence. He gave early promise of rising to the top of his profession from his talents and untiring devotion to it."

In October, 1861, Mr. Rich was articled to Messrs. Palmer, of Jarrow, and went through the usual course in the shops and drawing office, thus acquiring among the kindly and hard-working sons of the Tyne, that knowledge of work and how it should be done, which was of so much service to him in after years. While at Jarrow, he did not confine himself to learning the mere practical knowledge of what to do, but strove earnestly to acquire that higher knowledge of what to think, which lies at the root of all real progress in engineering. This striving led him, some time after the completion of his articles, to throw up the appointment he held in the drawing-office at Jarrow, and to enrol himself at the commencement of the winter session of 1886 in the engineering classes of the University of Glasgow.

Here Professor Rankine, with that kindly thoughtfulness which endeared him so much to his students, proposed to the Senate that Mr. Rich should be allowed, in consideration of his professional attainments, to complete his course of study in one year, instead of the prescribed period of two years. This boon, considerable to a man who had already been engaged in practical work, the Senate granted, provided Mr. Rich could pass the examination for admission to the Senior Mathematical Class. He not only passed this examination, but amply justified Professor Rankine's recommendation by carrying off, in addition to the certificate of proficiency in engineering science awarded by the University, the Walker prize for a written examination in engineering, two class prizes in the engineering class, the second prize in Natural Philosophy, and a prize for work done in the physical laboratory.

Concerning his work in the Natural Philosophy class, Sir William Thomson thus wrote of him: "Mr. Rich was one of the most distinguished students of the class, and the second prize was awarded to him by the votes of his fellow-students. Mr. Rich also worked with much perseverance and skill in the laboratory of the class." At the end of the session he was awarded the University medal for an essay on the "Doctrine of Uniformity." Perhaps the best testimonial as to his work at Glasgow is that which he received from Professor Rankine some time afterwards, when candidate for a chair of engineering, then vacant. Professor Rankine writes: "Mr. William E. Rich, C.E., has received from the Senate of this University, and from myself individually, testimonials of the highest order as to his conduct and success when a student of engineering science, but to what is stated in these testimonials, I wish to add the statement of my own conviction, that he is specially well qualified to do the duties of a professor of civil engineering. He possesses in a high degree the talent of expressing

his knowledge in a clear, simple, and methodical way, and he has also the character and manners which are best calculated to obtain for him the respect and regard of his colleagues and of the students."

In January, 1868, Mr. Rich joined as assistant engineer the firm of Easton and Amos (now Easton and Anderson), in which he was to spend the remainder of his life, and in April of the same year passed the examination—no light test for one not educated at the school—and obtained the diploma of Associate of the Royal School of Naval Architecture and Marine Engineering. He was in fact the first non-student who obtained this honour.

The work done by Messrs. Easton and Anderson is and has always been of a very varied character, and Mr. Rich found ample employment for all the knowledge he acquired as a student of engineering science. Among other branches geology was found specially useful, and to the study of this science he devoted much time, more especially with reference to its bearing on the question of water supply. In his capacity of assistant engineer he was employed in the more scientific branches of the firm's work, materially assisting in the design of the large sugar mills built in 1870 for the late Khedive of Egypt, and also in the designs for the early Moncrieff gun mountings for naval service.

While in this position Mr. Rich took much interest in the various trials of machinery conducted by the Royal Agricultural Society, to which Mr. W. Anderson, one of the principals of his firm, was at the time consulting engineer, and he designed several of the dynamometers used at these trials. These dynamometers were described in a paper read by Mr. Rich before the Institution of Mechanical Engineers at the Birmingham meeting in July, 1876, and which was published in ENGINEERING at the time.

As might have been expected, Mr. Rich obtained rapid promotion, and in June, 1878, ten years after his appointment as assistant engineer, he was admitted as a partner in the firm. Among the more important works undertaken by Messrs. Easton and Anderson, upon which Mr. Rich had been engaged since his admission to the partnership, may be mentioned the Antwerp and Seville Water Works, in the general arrangement of which he took an active part. He also took a large share in designing the sewage pumping engines for Buenos Ayres, under Mr. J. F. La Trobe Bateman, past-president, Inst. C.E.; the pumping engines for the Amsterdam Water Works, under Messrs. Quick; and he designed entirely the large hydraulic passenger lift for the Mersey Tunnel, under Sir James Brunlees and Sir Douglas Fox.

The sewage pumping engines for Buenos Ayres, and many others of the works undertaken by Messrs. Easton and Anderson, are described in a paper by Mr. Rich, "On the Comparative Merits of Vertical and Horizontal Engines and on Rotative Beam Engines for Pumping," read before the Institution of Civil Engineers, on April 22, 1884, and printed together with the discussion thereupon in the Minutes of Proceedings, vol. lxxviii., 1883-84, part iv. This paper, written primarily with the view of evoking discussion on the subject of pumping machinery, contains much that is of real and permanent value.

The hydraulic passenger lifts for the Mersey Tunnel formed the subject of a paper read before the Institution of Civil Engineers on May 4, 1886, and which, together with the discussion, was printed in the Minutes of Proceedings, vol. lxxxvi. (1885-86), part iv. For this paper Mr. Rich was awarded the Telford premium of the Institution of Civil Engineers. Mr. Rich took a great interest in the proceedings of the Institution of Civil Engineers and the Institution of Mechanical Engineers, and besides reading the papers mentioned above, frequently took part in the discussions.

Towards the end of last year, Mr. Rich's partnership having expired by effluxion of time, it was agreed, as giving greater scope for his abilities, that he should leave the firm, and with the commencement of the new year start in business on his own account as a consulting engineer, his partners considerately allowing him to devote all the time not necessary for the completion of the work he had in hand, to such new work as might present itself, and generally to getting himself into working order before the end of the year. Mr. Rich had many offers of work, and among the first fruits of his new venture was the testing, in conjunction with Professor Kennedy, of the Messrs. Davey, Paxman, and Co.'s engines used in driving the electric light installation at the Colonial and Indian Exhibition of 1886, the very able report on which appeared in ENGINEERING for November 26 last.

Mr. Rich was a man of high honour, and one who held strong views on personal religion, carrying conscience into all he did, not only in matters connected with his profession, but in the minor details of his life. As an engineer he was pre-eminently a hard worker, as those most intimately associated with him well knew. He leaves, besides his aged father and mother, a widow and five children to mourn his loss, and the congregation which assembled at the funeral service held in St. Mary's Church, Vincent-square, on December 28, showed the respect in which he was held, not only by his more immediate friends, but by the heads of the profession he served so well.

CLYDE SHIPBUILDING AND MARINE ENGINEERING IN 1886.

FIRST ARTICLE.

THE great shipbuilding industry of the Clyde has never passed through such a state of depression since 1879 as that which existed during the past year. Our monthly reports since the last annual summary, have doubtless prepared our readers for the very wholesale statement just made; for never since the time mentioned has there been a year's work attended with such comparatively small results. The twelvenonths' turnout of new shipping included 193 vessels of all kinds, the aggregate of which scarcely reached 176,000 tons. This meagre total shows a falling off to the extent of between 18,000 and 19,000 tons, when compared with the output of the year 1885. Its extraordinary meagreness becomes very patent when it is compared with the total output of the year 1883, when there were 413 vessels of all kinds built, aggregating 415,694 tons, thus showing that in the past year there was a falling-off to the extent of nearly 240,000 tons, as compared with the output of 1883. Again, by comparing last year's results with those of 1879, we find that they showed a slight increase, amounting to 7512 tons, the total number of vessels built being 191, which aggregated to 168,460 tons. These yearly totals show very marked contrasts. It may be remembered that the total output of new shipping on the Clyde was also very large in the years 1881 and 1882, and that there was a considerable falling off in the year 1884 from the grand and hitherto unapproached total of 1883.

Never at any former period have there been so many shipbuilding and boatbuilding establishments on the Clyde as there are now, the total number being about fifty. As might be expected, a number of these concerns are only of very small consideration when looked at in the light of their output for the year. There is also the fact that several yards had no output at all during the past year, and amongst them we may specially mention that of Messrs. Aitken and Mansel, at Whiteinch, a yard which in two or three former years has had a very considerable output. That yard remained closed during the whole year, but it is somewhat gratifying to know that a better condition of things will exist during the present year, the firm having recently booked at least one new order, which is said to be for a vessel of about 3000 tons for a London firm of shipowners. While speaking of this Whiteinch shipyard, we may note the fact that an adjoining yard, which has been occupied for several years by Mr. W. B. Thompson, of Dundee, is henceforth to be a "sealed book" so far as that gentleman is concerned. For some months during the past year it was entirely empty.

Much of the work done on the Clyde during 1886 consisted of contracts for Government vessels, a fairly large share of the orders given out by the Admiralty during the past one or two years having fallen to the lot of the Clyde builders. The total output of Government work during the past twelvemonth was 16,581 tons, being the largest year's output of that class of work yet recorded. Under this head we include additions to the British Navy, amounting in all to 13,150 tons. The other Government work included three vessels, aggregating 2784 tons, for the Indian Government, three small vessels for the Egyptian Government, and one torpedo boat each for the Spanish and Russian Governments. At this stage we may enlarge a little upon the work executed for the British Admiralty. It consisted, as we have said, of six vessels, all built of steel. The largest of them is a belted cruiser named the Australia, a vessel of 5000 tons, built by Messrs. Robert Napier and Sons, who also have on the stocks a sister ship, which is to be named the Galatea. All the other five Admiralty vessels are torpedo cruisers of the "Scout" class, and are named respectively the Mohawk, the Brisk, the Porpoise, the Cossack, and the Tartar, and each of 1630 tons displacement. They were built by Messrs. James and George Thomson, of Clydebank, who also built the torpedo boats for the Spanish and Russian Governments.

It is especially worthy of note that Messrs. Russell and Co., Port-Glasgow, again occupy the position of having put the largest amount of tonnage into the water during the year. It included seventeen vessels, of a total of almost 30,000 tons, as compared with nearly 41,000 tons in the year preceding. It should be mentioned, however, that the firm just named built none but sailing vessels during the year. They were all of very large size, the average being 1755 tons. The Fairfield Shipbuilding and Engineering Company (Limited), formerly known as Messrs. John Elder and Co., came second in order, their total output being 23,391 tons, as against 9026 in the year 1885, when they were seventh on the list. The third place in last year's returns is occupied by Messrs. Denny and Brothers, of Dumbarton, whose total output was 17,227 tons, or 734 tons in excess of their output in 1885, when they stood second in order. The next place is filled by Messrs. Scott and Co., of Greenock, their output being 13,191 tons; and they are followed by Messrs. Barclay, Curle, and Co., with an output of 12,520 tons. These five firms are the only ones whose output for the year was over 10,000 tons. Messrs. James and George Thomson follow, with 8650 tons; Messrs. A. McMillan and Sons, with 7892 tons; the London and Glasgow Shipbuilding and Engineering Company, with 7195 tons; Messrs. Caird and Co., with 6235 tons; and Messrs. Napier and Sons, with 5000 tons. These again are followed by thirteen firms whose output for the year ranged from 4893 tons down to 1200 tons.

Returning to the classes of vessels built on the Clyde last year, we may mention that paddle steamers occupied an unusually prominent position in the total output; indeed, the returns show that they attained the greatest aggregate for any of the past ten years. It amounted to 13,601 tons, or 8902 tons over the aggregate in 1885, and it was even larger in amount, to the extent of 155 tons, than the total paddle steam shipping launched on the Clyde in that sort of *annus mirabilis* 1883, which was then the highest year for paddle-wheel vessels since the revolution from paddles to screws had fairly set in. The screw steamers built in the Clyde shipyards numbered 67, and aggregated 73,857 tons, showing an increase of 7279 tons over the screw tonnage built in 1885, but 242,345 tons less than that built in 1883. As compared with the output in 1885, the sailing vessels built last year showed a decrease to the extent of 38,553 tons; but still the total output—which was nearly 66,000 tons—may be set down as the largest since 1877, with the exception of that of 1885, and that of 1882. Last year's turn-out of steam dredging plant was the smallest since the year 1880. Only a very small amount of work was done in barges. The returns for the past year in respect of steam yachts total up very well, there having been ten such vessels built of a total of 2123 tons. These returns are very slightly under those for the year 1885. No sailing yachts of any consequence were turned out last year from any of the yards famous for such craft.

The fact is now pretty familiar to all our readers that steel, as the material of construction in shipbuilding, is attaining more and more prominence every year. It is but a very few years since this material began to assume any prominence at all in the Clyde shipbuilding returns, and yet the returns for the past year show that the total output of steel shipping formed about five-eighths of the whole. During the year the steel-built shipping amounted to 122,213 tons, as compared with 53,091 tons of iron-built shipping, the remaining 668 tons being built of wood. Without giving the detailed returns for the preceding years, we may just mention that in the year 1881 the steel tonnage built was only 70,000 tons, as compared with 261,500 tons of iron-built shipping. Notwithstanding the fact that the use of steel has so greatly increased in shipbuilding, it is a matter of interest that the increase is very much more in the department of steam tonnage than in sailing vessels. Last year, for example, the proportions were 46,113 tons of iron shipping and 19,799 tons of steel shipping. The returns for the year, in respect of screw steamers, show that steel was employed in building 69,002 tons of such shipping, while the output of iron-built screw steamers was only 4855 tons.

NOTES FROM THE SOUTH-WEST.

Devonport.—Building operations at Devonport last year were confined to the Racoon, the Serpent, the Spider, and the Sandfly. The two former are cruisers of 1630 tons displacement, 4500 horse-power, 225 ft. long, and 35 ft. broad. They are composed entirely of steel, and are built on the protective deck principle; they are expected to steam 19 miles per hour. The Serpent is now advanced five-eighths towards completion, and the Racoon three-eighths. The Spider and the Sandfly, which were laid down in June, are built of steel, are of 440 tons displacement, 200 ft. long, 22 ft. beam, and 2500 horse-power. It is anticipated that these two vessels, which will be launched this year, will realise a speed of 20 knots an hour. Four new ships were brought to Devonport last year to be fitted for sea, viz., the Thames, steel cruiser, built at Pembroke, and whose engines, by Messrs. Penn and Sons, are about to be tried; and the Archer, the Cossack, and the Brisk, sister ships to the Racoon and Serpent, but of 1000 less horse-power, built by Messrs. J. and G. Thompson, of Clyde Bank, and whose machinery trials are now taking place.

Coal in North Wales.—The principal colliery proprietor in North Wales resolved on an important step on Saturday last. The price of best steam coal was increased 6d. per ton, and slack was similarly advanced.

Cardiff.—Last week's shipments of steam coal at Cardiff were larger than might have been anticipated. Prices have not improved, but a better feeling has generally prevailed. Ordinary steam coal has been making 7s. 9d. to 8s. per ton, while the best qualities have been selling at

from 8s. 3d. to 8s. 6d. per ton. Small steam coal has been rather weak. House coal has been in good demand at from 8s. 6d. to 8s. 9d. per ton. In the iron and steel trades, the prospects of the new year are considered to be tolerably encouraging.

Water Supply of Bristol.—A public meeting was held at Bristol, on Wednesday, in support of the new water works scheme for that city, the supply proposed to be utilised being that available at Sudbrook. Resolutions in support of the scheme were passed; and it was also agreed that it was highly desirable that the undertaking should be administered by the Bristol Town Council.

The Bute Docks.—The Bute Docks quayage, sidings, &c., cover an area of nearly 600 acres. The first dock was opened in 1839, and in that year the imports amounted to 603 tons. In 1849 the corresponding imports had grown to 103,177 tons, in 1859 to 156,046 tons, in 1869 to 302,132 tons, and in 1879 to 831,730 tons; in 1885 they stood at 1,067,208 tons. The exports in 1839 amounted to 7679 tons, in 1849 they had been carried to 723,917 tons, in 1859 to 1,712,452 tons, in 1869 to 2,511,369 tons, and in 1879 to 4,318,225 tons; in 1885 they stood at 7,043,344 tons. A new dock, which has just been completed, has a water area of 35 acres, exclusive of timber ponds, and is 2400 ft. long and 600 ft. wide. The bottom of the dock is 46 ft. below the level of the coping, and the depth of water will range from 39 ft. to 29 ft., according to the state of the tides. In addition to the ordinary quayage, which amounts to about 5900 ft., a jetty, 800 ft. long, and which will add about 1600 ft. additional berthing accommodation for the larger class of vessels, is now being constructed.

Railway Rates in the West.—On Thursday, the Railway Commissioners delivered judgment in cases which had been before them for some days, respecting the through rates *vid* the Severn bridge, of coal from collieries in the Forest of Dean to stations on the Great Western Railway, and also for traffic from certain places in South Wales to stations in the south and west of England. The Great Western applied to the Commissioners to rescind two orders made by them in the early part of the year in regard to these rates, on the ground that they were rendered unnecessary by the opening of the Severn Tunnel, while the Severn Company contended that the rates in force should be maintained, and others added. By the judgment of the Commissioners, the South Wales routes were cancelled, and the Forest of Dean route allowed at the reduced rates which the Great Western Railway brought into force on the opening of the Severn Tunnel.

The Bristol Channel.—Arrangements are being made for a meeting at Pill with respect to the best position for a harbour of refuge in the Bristol Channel.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—So far business has not been interfered with by the Christmas and new year holidays; the Glasgow pig-iron market has been very firm during most of the past fortnight. The price of warrants advanced this day fortnight from 43s. 11d. to 44s. 3d. per ton. On the following day they were at one time 1d. per ton over those of the preceding Friday, which were at that time the highest that had been paid during the year 1886. But the demand eased off to some extent, and the close was 4d. under the best, and 1½d. per ton under Wednesday's close. On Friday afternoon the ironmasters' annual returns, as to make, stocks, &c., were made known, but not till after the close of the market, so that they had no influence on the prices. There was no market on Monday of last week, and on the forenoon of the following day the annual returns prepared by the Iron Brokers' Association were issued, and they at once caused an improvement in the tone of the market, the prices advancing to 1½d. per ton over the preceding week's highest quotation. Up to 44s. 6½d. cash was paid, and the month's best price was 44s. 9d., but at the close there was a decline of 1½d. per ton. This day week still higher prices were reached in the forenoon market, up to 44s. 7½d. cash and 44s. 10d. one month, but the close in the afternoon was 2½d. per ton under the best. The market was rather quieter on Thursday, and it closed 1½d. under the previous day's final quotation. On Friday, however, the market was so strong that prices closed 3d. per ton higher than those of Thursday, and 5d. over the previous week's close. During the forenoon the prices reached 44s. 6½d. cash and 44s. 9½d. one month. There was no meeting of the iron ring in the afternoon of Friday, nor did any take place either forenoon or afternoon on Monday, owing to the holiday feeling being predominant. Business was opened for the new year, yesterday, when the market displayed a very buoyant tone. In the morning an advance of 11d. per ton was secured, and in the afternoon the advance was increased to 1s. 1d. over last year's closing quotation. In the forenoon business was done up to 45s. 5½d. cash, and 45s. 7½d. one month, and the top quotations in the afternoon were 45s. 7d. cash and 45s. 10d. one month, which were offered at the close by buyers, sellers wanting ½d. per ton more. The warrant market was again very strong this forenoon, when a further advance in prices to 45s. 9½d. cash took place. There was a considerable turnover in warrants. In the afternoon the market was likewise very strong, and a second advance of 2d. per ton was effected. Persons connected with the pig-iron department—such as makers, merchants, and users—have for some days been much interested in regard to the annual statistics upon the production, consumption, and shipments of Scotch pig iron, during the past year and on the stocks that were in store and in the makers' yards at the close of the year. It is not necessary to enlarge on those statistics here, but it may be stated that on the whole, they have given more satisfaction than it was anticipated. Since last report, one furnace has been blown out at Clyde Iron Works, and one at Calder Works, but with those that have been blown in at Glengarnock, and at Coltness Iron Works, there are now 75 furnaces in actual operation, as compared with 92 at this time last year. There has been very little change in the extent of the stocks of pig iron in Messrs. Connal and Co.'s public warrant stores during the past couple of weeks.

The Scotch Coal Trade.—Prior to the new year holidays, which begun last Friday, the miners in most of the Scotch colliery districts had for at least a fortnight, been working more regularly than had previously been their practice. Coalmasters have of late reported that coals were in some cases rather scarce, and that this condition of things had rather hardened prices. In one or two instances an advance of 6d. per ton has been secured, but that is not the general rule. The scarcity was caused by the desire to obtain supplies forward so as to meet the wants arising when the miners should be off work for their annual holidays. When the holidays are past it is expected that the pressure will be at an end. The current prices at Glasgow are as follows: Main coal, 6s. 6d. to 6s. 9d. per ton, f.o.b.; Ell coal, 7s. 3d. to 7s. 6d.; splint coal, 7s. to 7s. 6d.; steam coal, 7s. 6d. to 8s.; and the prices at the pits generally ranged from 1s. 6d. to 2s. 6d. per ton less than the f.o.b. rates. The coal shipping trade from the ports in the Firth of Forth has now declined in a marked manner, owing to the fact of many of the Baltic ports being closed with ice for the season. On the question of an advance of wages, there is for the present a state of comparative quietude, both in the east and in the west of Scotland. The Fife and Clackmannan miners have not yet got an advance of wages, whereas many of the Lanarkshire men have had two advances during the last four or five months.

Local Scientific Societies.—Since last report ordinary meetings of two of the local scientific societies have been held, namely, the Institution of Engineers and Shipbuilders in Scotland, and the Mining Institute of Scotland. At the meeting of the first-named body there was a continuation of the discussion on a paper previously submitted by Mr. Robert S. Moore, on "The Construction and Laying of a Malleable Iron Water Main for the Spring Valley Water Works, San Francisco." Interesting remarks were made on the subject by Mr. John Thomson, Glasgow, and by Mr. James Watson, water engineer, Dundee. The discussion on Mr. Biggart's paper on "Erecting the Superstructure of the Tay Bridge" followed, and all the speakers expressed great admiration at the methods adopted by Mr. William Arrol, the contractor for the execution of the work. Great praise was also awarded to Mr. Biggart for the interesting way in which he had laid the engineering details before the members of the Institution. A new form of reversible steam valve and an improved engine revolution counter were afterwards exhibited and described, and then Mr. G. W. Wade, of Hornsea, near Hull, brought under the notice of the members a very clever double-acting lever for reversing engines. The last-named invention greatly interested many of the members. At the meeting of the Mining Institute there was submitted a report by a committee on the recently passed Coal Mines Regulation Act. The discussion upon it was held over. Some interesting information was given to the meeting regarding gelatine-dynamite as a blasting agent in getting coal, and in the course of the proceedings it was stated that it was intended to have six of Pitkin's miners' electric safety lamps tried at Earnock Colliery, Hamilton. Mr. Robert Beith afterwards contributed a valuable practical paper on "The Sinking of Shafts, with special Reference to the System adopted for Fitting them for Pumping and Winding."

East of Scotland Engineering Association.—The sixth fortnightly meeting of this Association was held in Edinburgh last night, Mr. D. Millar in the chair. Mr. A. C. Elliot, B.Sc., President of the Association, read a "Note on Rankine's Method of Treating the Retaining Wall." He compared that method with the older one of Coulomb developed by Moseley and others. The great importance of the physical bases upon which Rankine founded his treatment was insisted upon. The more practical aspect of the question was also dealt with, but the author reserved his mathematical development for a paper to be read before the Royal Society.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the market was well attended and prices were again firmer, No. 3 g.m.b., f.o.b. prompt in Tees was quoted 35s. 6d. per ton. Considerable difficulty in fact was experienced in getting sellers to name a price, and in consequence of this business was very much hampered. All the makers held aloof and practically declined to quote. The telegrams from other iron centres were more favourable, and the news from America was especially encouraging. The reports from the Continent, too, showed that prospects were better. It is believed that fair shipments of English iron will shortly be recorded to the Continent. Exports of pig iron from Middlesbrough continue good considering the time of year. There is still a strong demand for hematite pig iron at 46s. per ton for mixed numbers f.o.b. east coast ports. In the manufactured iron trade there is nothing new to report except that inquiries are more numerous and prices are stiffening.

The Cleveland Blast Furnacemen and their Wages.—Yesterday the delegates from the Cleveland blast furnacemen again met the ironmasters at Middlesbrough and further discussed the wages question. The proposed sliding scale was duly considered, but no final decision was arrived at and the meeting was again adjourned. It is believed that the next conference will result in a settlement of the question.

The Make and Disposal of Pig Iron in Cleveland.—This afternoon the Cleveland Ironmasters' Association issued from their offices at Middlesbrough their official returns, from which it appears that during the month of December, of 155 blast furnaces in the whole of the North of England 85 were in operation, 70 being idle. The total make for the month reached 193,293 tons—an increase of 6600 tons on the previous month. The stocks now stand at 652,445 tons—a decrease of 15,327 tons on the previous month. The total shipments of pig iron from Middlesbrough reached 63,777 tons. During the year 1886 the total make of all kinds of pig iron reached 2,406,276 tons.

The Steel Trade.—All the steel makers continue busy, and quotations are firmer. Steel plates are selling at 6*l.* 5s., and angles at 5*l.* 15s. per ton less 2½ per cent. at works. There is a good demand for steel rails at 4*l.* 5s. per ton f.o.b. At most of the steel works there are orders in hand which will keep the plant fully going over the first half of this year.

Engineering and Shipbuilding.—Both engineers and ironfounders are getting busier, and quite recently some large contracts for railway material have been placed in the Middlesbrough district. The shipbuilders on the northern rivers are receiving more inquiries, and prospects are mending. Already there is a fair amount of work in hand at many of the shipyards.

The Ironworkers of the North of England.—For some time past the ironworkers of the North of England have been very irregularly employed, and have been earning little money. Many of the men have ceased to contribute to their trade association, which is connected with the Board of Arbitration—an institution which has been the means of dealing satisfactorily with wages and other disputes for so many years. It is now feared that unless something is done to stir up the men their association will cease to be represented on the Board of Arbitration, and the old brutal method of strikes and struggles will be resorted to in case of disputes of any kind between masters and men. Now is the time for the ironworkers to reorganise their association and seek the co-operation of the steelworkers and others with a view of strengthening the Board of Arbitration, which should occupy so comprehensive a position as to deal with nearly all trade disputes in the North of England. Such a reorganisation would be beneficial to both employers and workmen, as it has proved for so long a time in the manufactured iron trade.

The Coal and Coke Trades.—Coal and coke are unaltered.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Over Production in the Coal Trade.—The miners of South Yorkshire are agitating for a reduction in the output of coal. At a mass meeting, held this week at Whittington, they adopted this resolution: "That this meeting, clearly seeing that over-production engenders competition to a degree that makes it impossible for workmen in connection with coal and ironstone mining to earn a respectable living, believes, in view of our productive ability, the time has arrived when seven hours should be, in all cases, a working day, and that each person present do his best among his fellow-workmen to propagate the above as a policy."

Yorkshire Miners' Association.—The annual meeting of this association was held at Barnsley, this week. Mr. E. Cowey presided, and Mr. B. Pickard, M.P., was amongst those present. Mr. E. Cowey was elected president, and he, with Mr. J. Wadsworth, were appointed to represent the Association with a deputation that will shortly wait upon the Home Secretary in reference to the new Mines Bill.

Roundhay Park Railway Scheme.—The Parliamentary Committee of the Leeds Town Council are considering the advisability of having a suburban railway to Roundhay Park. Mr. Pullen, of the firm of Jefferson and Pullen, civil engineers, considers the plan before the committee objectionable, and has submitted one for an overhead railway, starting from North-street and ending in the Park. There would be two lines of rails, and, though single rails, each would be a travelling line. They would be capable of conveying 2000 to 3000 persons to the Park in an hour. The cost is roughly estimated at 85,000*l.*, including thirty large cars and six locomotives, worked on a system patented by Messrs. Jefferson and Pullen.

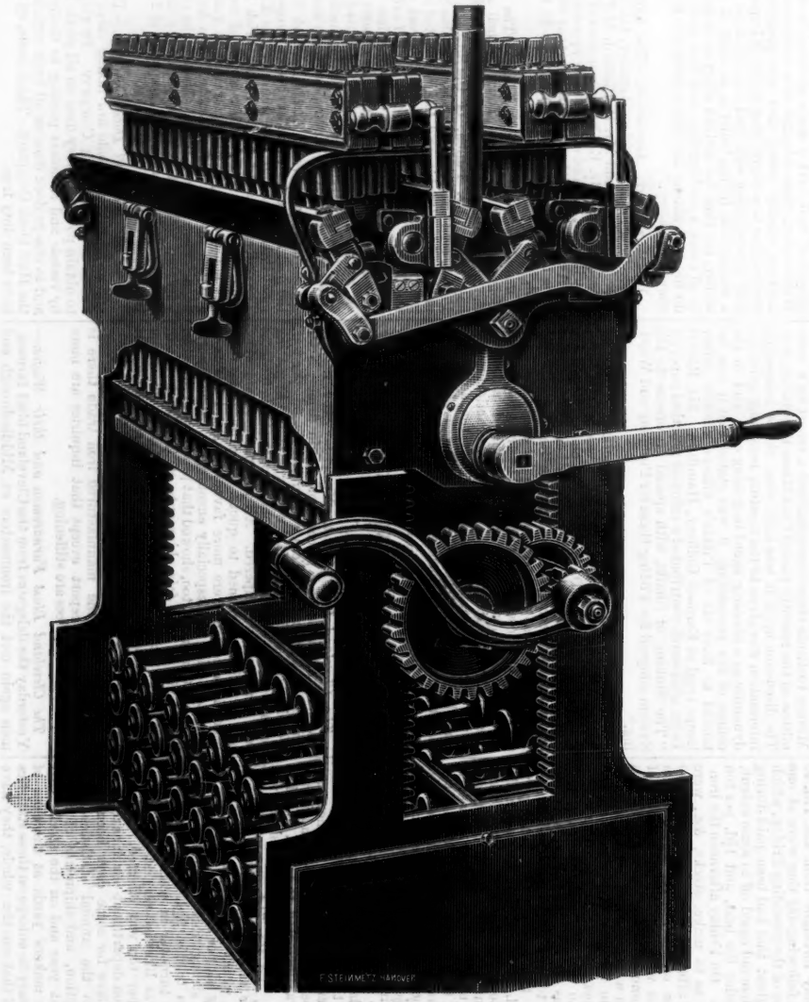
Coal and Iron Trades in the Erewash Valley.—During the past few weeks there has been a perceptible improvement in the coal and iron trades of the Erewash Valley. The orders for iron have been more brisk than for a long time, and there is altogether an air of confidence which has not been experienced for several years. This fact, and the severity of the weather, have had a marked influence upon the coal trade. Most of the pits are working tolerably well. It is not expected by the miners that there can be a return of the prosperity of 1874, as the output is now so much quicker.

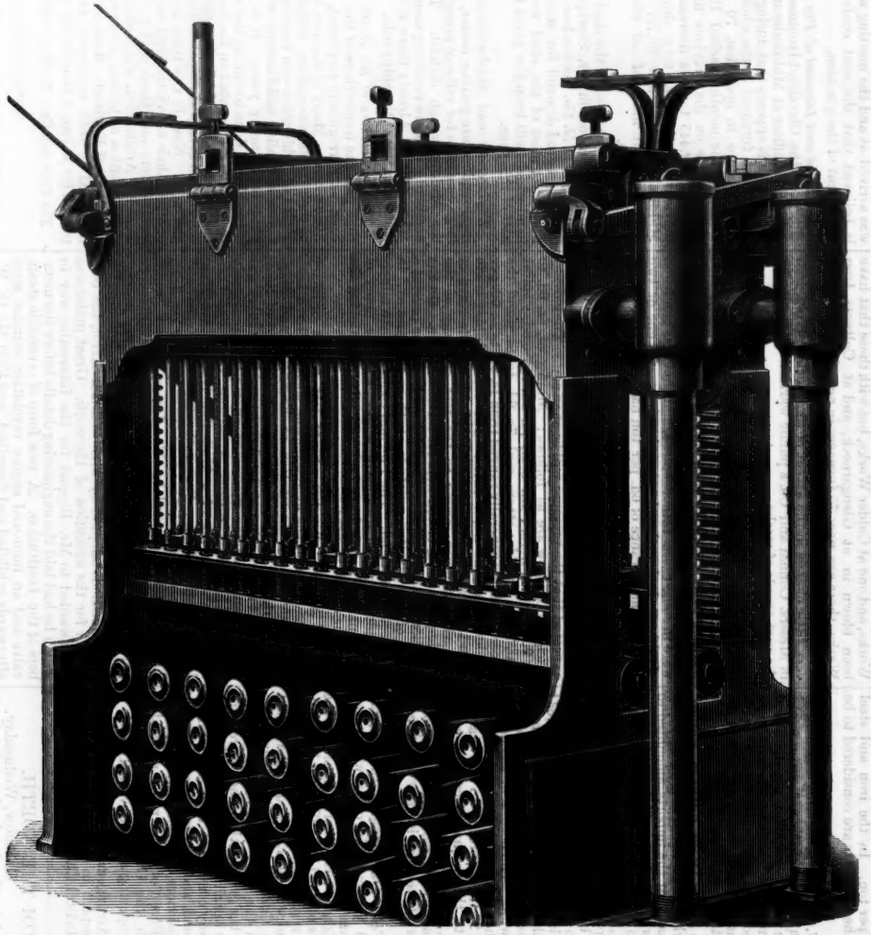
Goole and the Hull Dock Company.—The shipowners and merchants of Goole are taking steps to oppose the Bill of the Hull Dock Company. By this it is proposed to obtain power to levy dues on all goods landed at Hull by vessels and steamers passing to Goole or elsewhere, and to charge dock dues on all keels entering the docks of the Hull Dock Company. These keels, up to the present, have been duty free.

CANDLE-MOULDING MACHINE.

CONSTRUCTED BY MESSRS. J. AND W. BARLOW, ENGINEERS, ROCHDALE.

(*For Description, see Page* 20.)





NICOLAIEFF.—Large iron works and shipbuilding yards are about to be organised at Nicolaieff. The new works will be brought into operation next year. The central building, which is of semicircular form, will be wholly of iron and zinc. The shipbuilding yards will be adapted for the construction of vessels of all types.

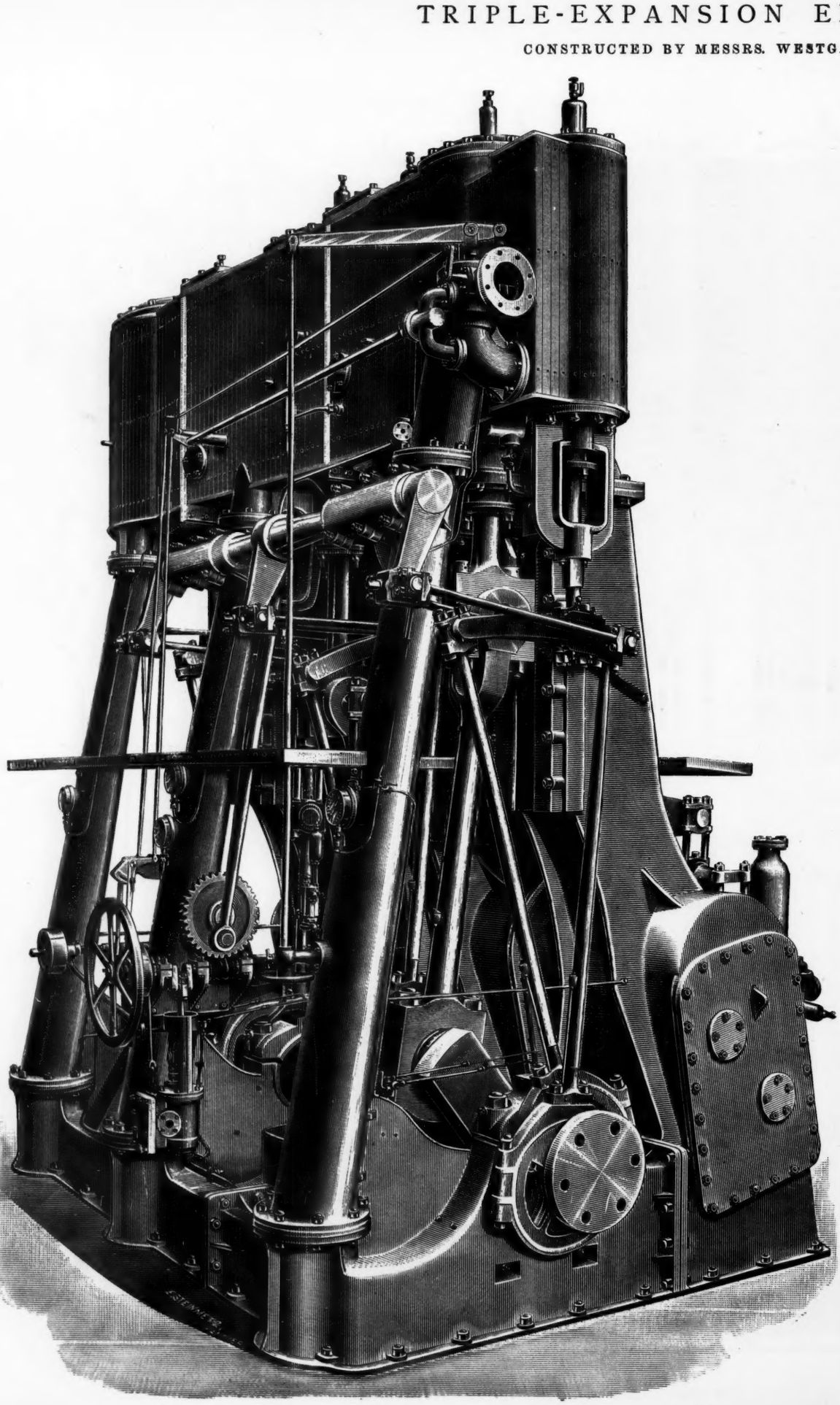
THE INSTITUTION OF CIVIL ENGINEERS.—The list of members, corrected to the 2nd inst.—being the sixty-ninth anniversary of the foundation of the Institution—shows that there are now on the register 1556 members, 2231 associate members, 488 associates, 20 honorary members, and 929 students—together, 5224, and representing an increase in the past year at the rate of 5¼ per cent., and of more than 100 per cent. since November 30, 1875.

LECTURES ON THE INDICATOR DIAGRAM.—It is not generally known that every winter there are delivered at the City and Guilds Technical College, at Finsbury, in addition to the ordinary classes for instruction in mechanical, chemical, and electrical subjects, short special courses of lectures somewhat resembling the Cantor Lectures of the Society of Arts. There is this difference, however, that the Finsbury lectures are of a much more practical type, and are, whenever possible, so arranged that all who attend them can also attend an accompanying course of laboratory demonstrations. The subjects last winter were steam boilers, optical instrument making, and coal tar dyes. During the past autumn there have been three courses, one on electric bells and one on electro-plating (chiefly nickel-plating), by Professor Thompson, D. Sc., and one on solders by Mr. Millis. During the remaining half of the session there will be two other courses, one by Professor Perry, F.R.S., on the steam engine indicator diagram, and one by Professor Meldola, F.R.S., on soaps and alkalies. Professor Perry's lectures, which are to commence on January 20, are six in number, on Thursdays, alternating with six laboratory demonstrations. Professor Perry has designed a number of special pieces of apparatus to illustrate the subject and make the principles of the indicator diagram plain to the non-mathematical mind. He will deal specially with the inaccuracies of diagrams, and with the newest and most improved forms of steam engine indicator.

TRIPLE-EXPANSION ENGINES C

CONSTRUCTED BY MESSRS. WESTGARTH, ENGLISH, AN

(*For Description, see P*



S OF THE S.S. "WARRINGTON."

H, AND CO., ENGINEERS, MIDDLESBROUGH-ON-TEES.

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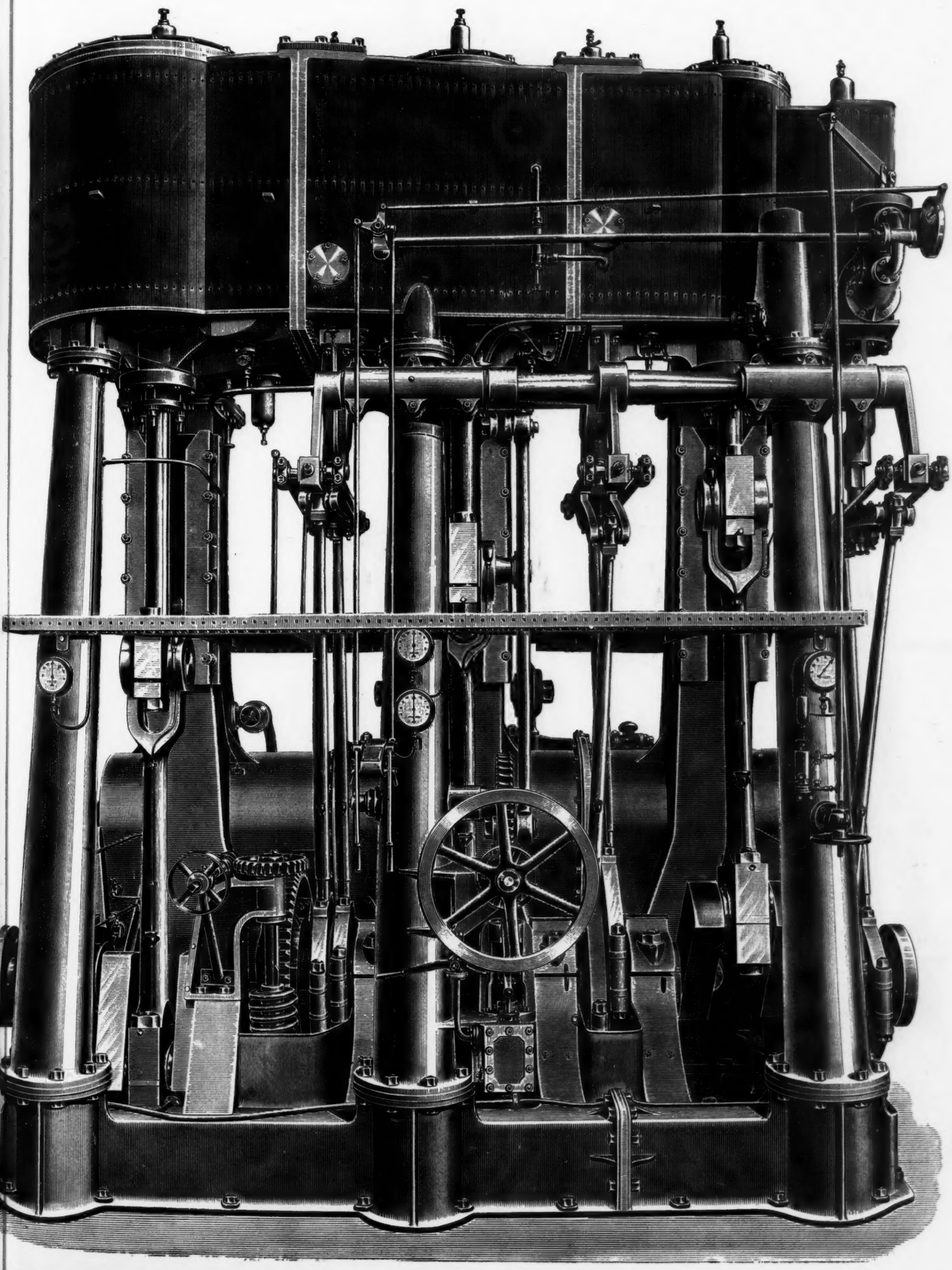

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With a Two-Page Engraving of TRIPLE-EXPANSION ENGINES OF THE S.S. "WARRINGTON."

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Students' meeting, Friday, January 7th, at 7.30 p.m. Paper to be read: "Experiments on Steam Engine Economy," by Edward C. de Segundo, Stud. Inst. C.E. Ordinary meeting, Tuesday, January 11th, at 8 p.m. Paper to be further discussed: "The Use and Equipment of Engineering Laboratories," by Professor Alex. B. W. Kennedy, M. Inst. C.E.

CHESTERFIELD AND MIDLAND COUNTIES INSTITUTION OF ENGINEERS.—Saturday, 8th January, at 2.45 p.m. General meeting at Nottingham, at the University Buildings, by kind permission of Alderman Lindley (chairman of the College Committee). New members elected by ballot will be announced. The annual election of representatives of the Institution to serve on the committee of management of the Stephenson Memorial Hall will take place. The following papers will be open for discussion: "Notes upon the Report of the Royal Commissioners on Accidents in Mines," and "Notes upon Safety Lamp Experiments, 20th November, 1886," by Mr. A. H. Stokes. It is intended to confine discussion on this occasion, as far as practicable, to safety lamps; and experiments, with apparatus specially provided by Mr. Morgan and others, will be exhibited in illustration.

SOCIETY OF ARCHITECTS.—The next meeting will be held in the Freemasons' Tavern, Great Queen-street, W.C., on Tuesday, January 11th, at 7 p.m., when a paper will be read by Mr. Ernest Farman, solicitor, entitled "Party Walls and Easements."

ENGINEERING.

FRIDAY, JANUARY 7, 1887.

STEEL PROJECTILES.

MESSRS. FIRTH AND SONS, Limited, of Sheffield, have forwarded us the following paragraph with the request that we should give it publicity:

"With further reference to the Note that appeared in our issue of the 17th ult., we are informed, on good authority, that Messrs. Thomas Firth and Sons, Limited, of Sheffield, have not merely become agents for the Firminy firm whose projectiles have recently given such excellent results, but that they have acquired from the Firminy Company, at considerable expense, the special processes adopted in their manufacture, and are now making these projectiles in Sheffield. It is true Messrs. T. Firth and Sons, Limited, have an order in hand for the Admiralty, but its value has been much over-stated; it was not given out, however, until four Firminy projectiles had been fired in England and had given the fullest satisfaction to the Ordnance Committee and the War Office and Admiralty authorities. We learn, also, that Messrs. Thos. Firth and Sons, Limited, are prepared to undertake orders to any extent to meet the requirements of our Navy, and will be able to manufacture in Sheffield upwards of 1000 tons of finished projectiles per annum. This being the case, there will be no necessity for our Government to pass orders to any French firms, since all our requirements can be satisfied at home; and as to quality we feel sure the best will be obtained, for the shell made under the Firminy process have proved superior both in France and in England to those of any other maker."

We very gladly publish the above, as it contains information of a very reassuring character to every one knowing, and concerned in, our present helpless condition in the matter of armour piercing projectiles. As Messrs. Firth and Sons take exception, and possibly with some reason, to some of the statements contained in our Note of the 17th ult., we have made careful inquiries and are informed that the history of the order for Firminy projectiles is accurately as follows. On June 25, 1886, a Firminy 10 in. shell was fired on board H.M.S. Nettle, against a plate of the Conqueror type. This plate was manufactured by Messrs. Sir John Brown and Co., and had been tested, in February, 1881, by three rounds from a 9 in. R.M.L. gun firing a 250 lb. Palliser shot and 50 lb. of powder. Nine surface cracks had then been developed in the plate, and one large crack extending from point of impact to edge and going right through plate. A second Firminy shell (12 in.) was fired on August 19 last, against an 18 in. compound plate by Sir John Brown and Co., of which plate Messrs. Brown and Co. wrote on October 18 that it was a "fair average plate and would have been accepted by the English Government or any other Government at the time it was made, two years ago."

On September 30 the Admiralty wrote to the Ordnance Committee, inclosing a letter from Sir William Armstrong, Mitchell, and Co., offering to supply 200 12 in. and 200 9 in. Firminy shell, and expressing their desire that this offer should be accepted. On October 6 the Ordnance Committee recorded their opinion that, "If it is determined to purchase steel armour-piercing projectiles at once without waiting for the trials in progress, the Committee consider that it would be safest to purchase them from Firminy." On October 18 the Director of Artillery informed the Committee that the Admiralty had decided to order the 400 Firminy shell, but through Messrs. Firth and Sons, who, "since the above was written, have become the sole agents for Firminy." On October 23 the third Firminy shell (the first in the series of current experiments) was fired against a 16 in. compound plate. With the settling of the contract with the representatives of the Firminy firm (then Messrs. Firth and Sons), and some subsequent negotiations with which we need not concern ourselves, the record is brought to date; this order was given, as we see, from the above paragraph, after the second shell in the trials was fired. We should not have been thus particular in giving details which we have taken pains to have exact, were it not that we are extremely anxious not to lie under any imputation of doing an injustice either to Messrs. Firth and Sons, or to the Ordnance Committee, as we consider that both the manufacturing firm and the official body have acted with much good judgment and enterprise. We are informed that Messrs. Firth have been in possession of the Firminy method of manufacture since September 26 last, and are losing no time in extending and adapting their plant for the production of the shot which have given such good results. No better illustration could be found of the truth of our remarks last week, that the British manufacturer would eagerly respond to any encouragement on the part of the authorities, and that the spirit of enterprise, so essentially an English characteristic, and which cannot be repressed even by official discouragement, is always ready to strain every sinew in making up for lost time and wasted opportunities. Last week we mentioned the rumour of Sir John Brown and Co's. negotiations with Creusôt, and now we record the promptness with which Messrs. Firth and Sons have concluded arrangements with Firminy; these things help to prove that the energy and resource of this country are practically unlimited, only they must be given some encouragement to develop.

There are two or three statements in Messrs. Firth and Sons' paragraph heading this article which require some comment. First we are told that though Messrs. Firth and Sons have an order in hand for the Admiralty, "its value has been over-stated." We cannot but hope that this assurance must be accepted with reserve, the more especially, since the order to the Firminy Company, through Messrs. Firth and Sons for 200 12-in. and 200 9 in. shell, was confirmed in November. The total weight of these projectiles cannot be less than 200 tons, and taking the French makers' price to the French Government of 3 francs per kilo., or 125*l.* per ton, the total amount of this first contract cannot be less than 25,000*l.* Indeed it would be unreasonable to expect this preliminary order to be executed at the rate just named. It would be a matter for regret if the first order given out were on a more limited scale than that announced by us some weeks since.

The next point that calls for comment is the limit in their capacity of production, as stated by Messrs. Firth and Sons. When they are in working order we may rely upon them to the extent of "upwards of 1000 tons of finished projectiles per annum." That we can rely upon so much is a source of much satisfaction, more especially when we bear in mind that the quality of the Firminy steel will be at least maintained, and probably improved, in the hands of the eminent English makers. But 1000 tons per annum! This amount will not by any means satisfy the requirements of our Navy, to say nothing of our land defences, and the limit of production thus set by the makers themselves, emphasises the necessity of encouraging other English manufacturers to imitate the enterprise already shown by Messrs. Firth and Sons. Assuming an average weight of 500 lb. per each shell, we may in full confidence anticipate from them an output of 4000 projectiles per annum. But at the present time Russia possesses 14,000 such shell, and France 8000, so that if we have to rely upon one source of supply, two years will pass before we are in the same position in this respect as France is in to-day, and more than three years before we can equal Russia's actual stock. To those who believe that England's future position amongst nations depends on her naval supremacy and armament, these facts afford food for serious reflection.

Of course if the Firminy firm were the only manufacturers possessing the secret of producing chrome steel suitable for the very highest class of projectile, we should have to rest content with things as they stand at present, and be thankful that English manufacturers of the highest responsibility had acquired a knowledge of the process. But this is not so. At least two other sources of supply are open to us, Holtzer and St. Chamond; possibly a third in the St. Etienne Company. That this is so is proved beyond a question by the results obtained only the other day at Garves, when four 1716 lb. shells were fired against iron plates 19.69 in. thick. These shells were furnished respectively by Holtzer, St. Chamond, Firminy, and St. Etienne, the names being given, according to the practice of the French official reports, in the order of merit in the result obtained. In accordance with the standard tests, the shot were fired obliquely against an iron target, and the results obtained were just such as might have been expected when huge masses of hard and homogeneous material were projected at the velocities obtained. No material difference in the behaviour

of the first three shell, nor in their condition after traversing the targets, was noticeable. The areas of the holes made in the latter were as follows:

Holtzer, 25.20×17.84 in. = 449.5 sq. in.
St. Chamond, 23.62×19.69 in. = 465 sq. in.
Firminy, 20.08×18.51 in. = 371.7 sq. in.
St. Etienne, 24.21×19.69 = 476.6 sq. in.

The Firminy projectile apparently struck the target rather less obliquely than the others, as the area of perforation was smaller; the record of the deformation resulting from the work done, by the Holtzer shell, taking all points together, was definitely more satisfactory than either St. Chamond or Firminy. The St. Etienne shell would appear to have been somewhat too soft, but it is, on the whole, fair to assume that if these gigantic experiments were repeated, the names of the makers might appear in a different order, so little variation is there in the excellence of the steel they manufacture. The following is the Table of results obtained:

Garves, December 29, 1886. Test of steel shells, 16.54 in. against iron plates 19.69 in. thick, fired at an angle of 20 deg.

Weight of projectile	1716 lb.
,, ,, powder charge	396 ,,
Velocity necessary to perforate target, per second	1345 ft.
Actual velocity measured	1410.5 ft.
Range	406 ft.

—	Makers of Shell.			
	Holtzer.	St. Chamond.	Firminy.	St. Etienne.
All four shell traversed the plates and remained intact..	without cracks	without cracks	without cracks	5 cracks of no great depth.
Diameters of oblique holes made in plates.. ... in.	25.20× 17.84	23.62× 19.69	20.08× 18.51	24.21× 19.69
Total compression of projectiles .. .. .. in.	.35	.24	.28	.79
Compression of head .. in.	.31	.189	.24	.71
Bulging in inches { in the ogive portion	.051	.024	.063	.205
Bulging in inches { in the cylindrical portion ..	.071	0.55	.146	.177
Deviation of the point of the shell from axis	.020	.059	.059	.375

We think the above Table will be studied with much interest and profit, representing as it does the latest and largest development of armour-piercing projectiles in France, which has pre-eminently taken the lead in this important subject. The few shells fired last autumn at Shoeburyness taught a very useful lesson to us—the inefficiency of our cherished system of compound armour, and the necessity of following foreign practice in the adoption of steel. But beyond this they have been of little use; the real value of the Firminy and Holtzer shells could not be deduced from the damage they wrought upon the compound target, except to show us what we may expect on any coming naval campaign. But the above Table is of immense value, and should be taken to heart by the authorities. It cannot be urged that because these four great shells were fired against an iron target no accurate appreciation of their actual or relative values against steel can be arrived at. French artillerists have decided that this oblique fire test is precisely the equivalent of normal fire against a Creusôt steel plate. For example, the condition of test specified by the French naval department for 12-in. projectiles, is either normal fire against a Creusôt steel plate 11.75 in. thick, backed with 33 in. of timber, and with a striking velocity of 1500 ft. per second, or else fire at an angle of 20 deg. against an iron target of the same thickness and with similar backing, but with a reduced velocity of something under 1300 ft. per second. No exception can be taken to this test by our authorities if—as we are informed—they have consented (and very rightly so under existing circumstances) to accept this test for the present lot of Firminy projectiles now in hand.

If this be so, then with the information afforded by the recent results obtained at Garves, the authorities might purchase without hesitation either of Holtzer or St. Chamond, as they have done of Firminy, or they might without fear hold out similar inducement to other English makers as they have done to Messrs. Firth and Sons. In fact, if we are to be sufficiently provided with shell that will pierce the sides of hostile ironclads, there is no choice in the matter. As we have said above, 1000 tons per annum will not by any means supply our requirements, nor even place us on a level with leading Continental nations, whose existence will never depend, as ours must do in any great war, on naval superiority. One serious feature in this all-important question is that of cost; assuming that we can produce as cheaply as our neighbours, and this assumption is not an unreasonable one, steel projectiles will cost at least 120*l.* a ton, and many thousands of tons will be required, and have to be paid for in the shortest possible time.

NAVAL ADMINISTRATION.

IN Lord Brassey's "Naval Annual," a review of which has already appeared in these columns, the author indulges in some reflections and criticisms on Naval Administration, which are worthy of more than passing notice. In a chapter on "Suggestions for Reforms at the Admiralty and in the Dockyards," Lord Brassey says, "It must be admitted that the difficulties inherent in the management of industrial establishments by a Government department, have not by any means been completely overcome in our English dockyards." This is a very safe statement and puts the case mildly. It could well have been carried higher, for the author might have said that difficulties inherent in the management of industrial establishments never can be completely overcome until the present system of direction is entirely reorganised. Directors of dockyards, however able—and no better could be found than the present director—may supersede surveyors of dockyards, civil assistants to admiral superintendents may be appointed, and any other shuffling of the official pack resorted to with exactly the same effect—that things will go on precisely as they have done from time immemorial. "The cost of ships," says Lord Brassey, "must depend primarily on the administration of the yards, and the supervision of the workmen on the part of the professional officers." Very true; but what can that supervision be worth when the professional officers, even the highest in rank, have not the power of themselves to discharge the most incorrigible idler? "We want less work on paper," continues the author, "and more personal activity on the part of those to whom we look for the direction of the dockyards. In the yards, as in Whitehall, the tendency is too much to sit in an office and to delegate the direction of large bodies of workmen to subordinates whose standing is not sufficient to invest them with the needful authority." Very true again; but what professional officer, constructor, or engineer will care to go amongst his men when he has no real control over them? The fact is that throughout the dockyards all professional officers, together with their assistants and subordinates through all ranks, are subject to the rule of a dominant caste; inferior to them in all requirements of the position, but governing them with absolute power. The Royal Dockyards are the last strongholds of feudalism in Britain. In them rank, or rather caste, and not fitness, rules. An admiral superintendent at best treats his professional officers with easy condescension. He may acknowledge the usefulness of their technical knowledge as he will value the ability of his butler to draw corks; but to admit them to terms of equality never enters his head. The tendency of his whole life's training has been to incapacitate him from such a feeling, for from the time he was appointed to a command he has been an autocrat accustomed to implicit obedience. This is the sentiment that dominates every grade in a dockyard, so that the rank and file look on professional officers in much the same light as boys look on ushers in a school; it is the superintendent who is the principal.

Lord Brassey gives utterance to no such reflections as these in his work, but they are irresistibly suggested by some of his statements of fact. Were his lordship able to go, an unknown and obscure individual, into any one of our Royal Dockyards; were he to see how work is done or left undone; were he able to hear the remarks made and see how utterly powerless professional officers are to move, however great their zeal; and finally, had he been accustomed to the perhaps rough and informal but effective supervision of our best private yards, we think he would be likely in future numbers of the Annual to pen some such remarks as we have made above. Who will say that the chiefs of the constructive and engineering departments in the Royal Dockyards hold that position, or are invested with that dignity to which the great concerns intrusted to their care should entitle them, or their undoubted scientific attainments should command? A few weeks ago the building of one of Her Majesty's vessels, in the opinion of the professional official who actually superintended it, was carried out in an exceptionally speedy and efficient manner, whereupon that professional officer ventured to pen a few words of approbation to his men. But this was contrary to the official code, and the autocrat of the dockyard rose in his might. A minute was prepared, and the unfortunate constructor received such a public snubbing as would have effectually destroyed any authority he might have been supposed to possess over his men. Surely no good can come of a system which crushes out of high officials all energy and zeal, to say nothing of self respect, by such courses as these. A Barnaby or a White, in touch with the public, may acquire sufficient heterodox authority to enforce their views by simple force of character, but what chance has a mere chief constructor or engineer in a dockyard? The best he can do is to bow to the system and keep himself out of hot water. Such a line of conduct inevitably becomes the rule with all professional officers and all dockyard employers; their constant aim is to avoid responsibility.

There is one other point in Lord Brassey's book to which we would like to make reference. After speaking of the more desirable manner, compared to our own, in which the French Naval Estimates are put before the nation, the author goes on to say "A careful study of an official paper circulated with the estimates would do more than any speech, however able, to assist in the consideration of difficult questions. The introductory statement might be supplemented, as Sir Spencer Robinson has suggested, by a report from the first sea lord on those numerous and important subjects which must be determined mainly by his advice. A similar report could be prepared by the controller on the *matériel* of the fleet. Documents of this kind are presented every year to the Secretary of the United States Navy and circulated officially. Such reports would not only supply to the country many valuable suggestions, but would give those highly placed officials by whom they were prepared a direct and personal responsibility for the policy carried out on their advice." We hardly know whether to wonder at the ex-Parliamentary secretary's simplicity or our own for taking him *au sérieux*. The Parliamentary speeches, "however able," that prelude the discussion on the Navy Estimates are not made "to assist in the consideration of difficult questions," but for the political purpose of glorifying the party in power and to delude the British elector into the idea that we have an adequate navy, and to obtain his support in his more dominant frame of mind as the British tax-payer. But to whatever we may owe the suggestion it is none the less excellent and we have more pleasure in subscribing to it as we put forward the same idea in these columns several months ago. The annual debate on the Navy in the House of Commons is more or less a farce, the fact that it is usually carried on by one or two members before empty benches is evidence of this. The First Lord or Parliamentary secretary, if the chief of the Board is in the Upper House, has put into his mouth a few of the most reassuring statements, and the votes are passed as a matter of course. It is true there is often a good deal of desultory criticism, but no one heeds it much. Certainly there was an exception to this rule some months ago, when public interest was raised to something approaching an adequate degree by the extraordinary energy of the press, and the supplementary estimates were voted, and no doubt recent political events will give the coming estimates a transient interest; but our normal condition appears to be one of lethargy and indolence from which it would seem nothing but the enemy at our gates will awaken us. A formal document, issued officially by the Admiralty, in which the Board would give an account of its stewardship, would be a vast improvement on the present frothy speeches in the House. Such a publication could be soberly criticised, and misleading statements, or lack of proper information, condemned without the claim for indulgence to Parliamentary utterances being allowed. We sincerely hope that Lord Brassey will not allow his suggestion to rest, but will bring all his energy and influence to bear on carrying it to a practical issue.

THE TELEGRAPHS OF THE WORLD.

THERE are now ten submarine cables at work between North America and Europe. The first of these was laid in 1869; the second, in 1873; the third, in 1874; the fourth, in 1875; the fifth, in 1879; the sixth, in 1880; the seventh and eighth, in 1882; and the ninth and tenth, in 1884. Six of

these cables start from Valentia (Ireland); two from Brest; and two from Penzance. The last named were laid by the Mackay-Bennett Company, which has also communication with Havre, as well as with Emden in North Germany. As regards South America, communication is established between that continent and Europe by two cables commencing at Lisbon and terminating at Pernambuco (Brazil). Telegraphic communication between England and India is assured by two cables, leaving Bombay, touching at Aden and Suez, restarting again from Alexandria, and traversing the Mediterranean as far as Marseilles, touching on the way Malta and Bona (Algeria). Another cable touching at Lisbon and Gibraltar, unites Malta and Falmouth. English enterprise has developed the largest extent of submarine telegraph. Great Britain has now communication with France by eight cables laid between Dover and Calais; with Portugal, by a cable touching at Vigo and beached at Lisbon; with Spain, by two cables between Falmouth and Bilbao; with Germany, by four cables laid between Emden and Lowestoft; with Norway, by two cables beached at Arendal and Ekersund; with Sweden, by a cable beached at Gottenburg; with Denmark, by a cable commencing at Newcastle and terminating at Londerwig; with Holland, by two cables laid between London and the Hague; and with Belgium, by a cable from London to Ostend. England —or to speak more correctly, English capitalists— possesses further cables between Tripoli and Malta; between Malta and Sicily; between Alexandria and Otranto, touching at Candia and Zante; between Alexandria and Aleppo, touching at Cyprus; between Alexandria and Port Said, between Suez and Aden, touching at Suakim in the Red Sea; between Suakim and Jedda, across the same sea; and between Madras and Australia, in the Indian Ocean, uniting *en route* Penang, Singapore, and Java. It was by this latter cable, with the aid of another between Singapore and Saigon, Hue and Haiphong, laid in 1885, that France received intelligence of the war which she waged for some time in Tonkin and Cochin China. In the China Sea English companies further own cables uniting Saigon, Hongkong, Foochow, and Shanghai, on the one hand, and Haiphong, Hong-kong, Amoy, and Shanghai on the other. Two cables which unite Shanghai and Japan (Nangasaki) to the Corea and Siberia, are also English property. Yet, again, on the African coast, a cable leaving Cadiz and running to Senegal, touching on the way at the Canary Islands, has been laid by English capital, which has further developed another cable from Aden to the Cape, touching at Zanzibar, Mozambique, and St. Laurent-Marquez. Australia is united to New Zealand by a cable from Sydney to Nelson; France is united to Algeria by three cables laid between Marseilles and Algiers, while another cable, beached at Marseilles and Barcelona, unites France to Spain. Russia is united with Denmark by a cable between Libra and Copenhagen; with Sweden by three cables between Nystad and Stockholm; and with Constantinople by a cable laid between that city and Odessa. This cable, prolonged across the Sea of Marmora to the Archipelago, will connect Constantinople with Salonica. Austria possesses a cable from Trieste to Corfu and Zante. A small cable between Otranto and Vallonia puts Italy in communication with Turkey. Corsica and Sardinia are united by cables of no great length—first, to France; and secondly, to Italy. Another cable must be placed to the credit of the English, viz., that uniting Kurrachee in British India with Turkey in Asia. This cable passes down the Persian Gulf and touches at Bushire and Jask. In the Western world the Antilles are linked with the United States by a cable commencing at Georgetown in British Guiana. Another cable unites Jamaica to Colon in the Isthmus of Panama. On the eastern coast of South America a cable, commencing at Para, runs to Buenos Ayres, touching at St. Louis, Para, Pernambuco, Bahia, Rio de Janeiro, Santos, Desterro, Rio de Sud, Chry, and Monte Video. On the western coast of South America the principal towns are united by a cable commencing at Tehuantepec in Mexico and terminating at Valparaiso (Chili). In the Gulf of Mexico a cable unites Vera Cruz to Tehuantepec and Galveston. The Caspian Sea has also a cable, which crosses it between Baku and Krasmowodsk. Although this summary of the world's submarine telegraphs is tolerably extensive, it is quite possible that it is still not quite perfect, so vast has been the development of submarine telegraphy.

BERNSTEIN'S SYSTEM OF ELECTRIC LIGHTING.

MR. BERNSTEIN'S name has long been associated with electric glow lamps. The special features of his system are that the carbon conductors are of large cross-section, and consequently offer but little resistance to the passage of the current, and that the lamps are arranged in series, and not in parallel as is customary. A current of 9 to 10 ampères is employed, and traverses the whole of the lamps in succession, and thus the size of the copper conductor is limited to that required to carry this current, and is of equal cross section throughout its length. The objection which naturally arises to this arrangement is that the failure of any lamp will break the circuit and cause the cessation of the current. Mr. Bernstein has, however, avoided the difficulty by the invention of one of the most novel and ingenious devices which has appeared for a long time in electric lighting. Around each lamp there is arranged a shunt or by-path having a resistance some 500 times that of the lamp. This shunt consists principally of a minute portion of oxide of mercury, mixed with carbon powder to render it conducting. It is contained in a metal

Fig. 1.

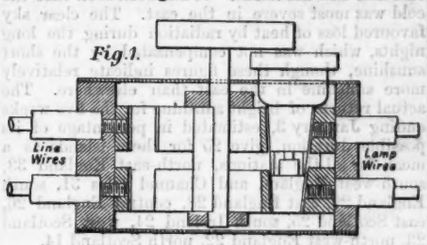


Fig. 2.

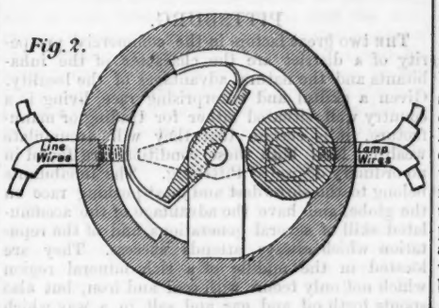


Fig. 3.

cup into which the point of a screw enters, and its resistance can be adjusted by the pressure put upon it. So long as the carbon conductor of the lamp (it is not a filament) is intact, the difference of potential between its terminals (say 10 volts) will only send a very small current through the shunt, and there is no effect beyond this trifling leakage. But when the conductor fails, as they all must do sooner or later, the difference of potential increases very greatly and the current through the shunt instantly grows large enough to heat it strongly and reduce the oxide of mercury to the metallic state. When this is done the condition of affairs is immediately changed, and the resistance of the by-pass sinks from 500 ohms to less than one. Although this action requires a good many words to describe, it takes place instantly—so rapidly that it does not effect the other lamps, which continue to burn as before. The annexed engravings show the by-pass or fuze both separately and in connection with a switch. The fuse is situated in a plug formed of two taper pieces of metal united by two strips of vulcanised fibre. One piece of metal has a small socket and the other a screw fitting into the socket, and holding therein the mixture mentioned above. The plug fits into two taper seats, which embrace its ends and are in electrical connection with the two leads of the lamp. It is provided with a head by which it can be inserted and withdrawn, and it must be placed in its socket before the lamp can be lighted, since its intrusion is necessary to displace a spring which short-circuits the lamp terminals and allows the entire current to pass through it, until it is raised by the plug. Further, when the switch handle is turned it locks the plug and prevents its removal. The tension of the current employed is 10 volts for each full-sized lamp, and consequently on a moderate-sized installation it ranges up to 1000 volts and more. This necessitates that great care shall be taken to secure perfect insulation, and for this reason the switch we illustrate has been devised. The main leads, highly insulated, enter and leave the case in apposition, while on the opposite side the leads go to the lamp, entering insulated sockets at each end of it. We shall shortly publish an engraving of the lamp and shall then speak more in detail of its construction. When the lamp is extinguised the ends of the main leads are connected together by a curved spring, while the lamp leads are insulated, and may be handled with impunity. The current now flows into the switch case, and out again to the next lamp. But when the switch is turned, the main leads are connected respectively to the lamp leads, and the current flows across the switch to the lamp and back again through the switch to the next lamp. The Bernstein system, which can be seen in operation at the company's works, Commercial-road, Chelsea, S.W., seems to hold the same place in incandescence lighting that the Brush system does in arc lighting. It works with the same current of 9 to 10 ampères, whether few or many lamps be in circuit, and can be extended over a circuit of many miles without serious loss, and without increasing the size of the conductor; when the generator is properly regulated, lamps can be turned in and out just as required; and, lastly, it requires but little skill to work it. These characteristics have proved valuable in arc lighting, and should be equally beneficial in the case of glow lamps. There is, however, one point which will bear improvement, and that is the appearance of the lamps and fittings, which are wanting in artistic merit. No doubt this point will be attended to now that success has been attained. Already there are three installations at work with very good results, and lamps which have been in action for 1000 hours show no signs of blackening. Their increase of resistance is very small, and the light emitted per watt is practically the same as at first. Their efficiency is high, the 35-candle lamps taking only 95 watts, and the smaller lamps in proportion.

THE WEATHER OF DECEMBER, 1886.

SEVERE weather has occurred in the first month of winter. The predominant wind has been from N.W., and remarkably boisterous, but the variations of the winds, both in direction and force, have been sufficient to give every variety of weather that could be expected at the time of year. As regards districts, the differences in the weather have been as remarkable as they have been in relation to time. When snow has been falling in Scotland, England has had clear weather, and while heavy snow has been falling in England, Scotland has had an open sky.

The mean atmospheric pressure and temperature, at extreme positions, to which the Isle of Man is central, were as follows:

Positions.	Mean Pressure.	Difference from Normal.	Mean Temperature.	Difference from Normal.
	in.	in.	deg.	deg.
North ..	29.47	below 0.22	37	above 3
South ..	29.76	,, .22	43	,, 1
West ..	29.64	,, .39	43	nil
East ..	29.58	,, .29	37	below 3
Central ..	29.61	,, .17	41	,, 1

The distribution of rain (including melted snow), both as regards frequency and amount, may be roughly inferred by the following results:

Places.	Rainy Days.	Amount.	Difference from Normal.
		in.	in.
Sumburgh	29	4.65	above 0.32
Scilly	29	5.80	,, 1.70
Valencia	27	7.03	,, 1.20
Yarmouth	20	3.40	,, 0.45

Snow was reported in the north on 8 days, in the west on 3, in the east on 3, in the central on 2, the south district on one or two.

Atmospheric pressure was remarkably low, the departure from the normal being most pronounced in the east, so that the mean distribution was such as to agree with the resultant of the mean daily directions of the winds over these islands, which, both as regards frequency and force, testify to a prevalent and strong wind from W.N.W., the normal resultant being W. by S. These north-westerly winds are in correlation with the cold experienced in the north and east, and coming from the Atlantic they brought plenty of rain, for in all districts the rainfall was, both in quantity and frequency, above the averages.

Rainfalls exceeding 1 in. in twenty-four hours were measured on the 8th at Belmullet, 1.01 in.; 14th, at Prawle Point, 1.04 in.; 15th, at Spurn Head, 1.00 in.; 27th, at London, 1.34 in. (including snow which measured 8 in. deep on the ground); at Scilly, 1.22 in.

A thunderstorm with heavy hail squall occurred at London on the 8th, 8.30 A.M.; and lightning and thunder were experienced locally at various times. Aurora was seen in the north on the 27th and 29th.

The unprecedentedly low atmospheric pressure, 27.38, occurred at Belfast, with rain, on the 8th, at 1.30 P.M.; the highest, 30.55, occurred on the 31st with fog; hence the absolute range of the barometer for this month was 3.17 in.

The highest temperature, 56 deg., was recorded at Hereford on the 6th; the lowest, 6 deg., at Brookeborough, on the 20th. Striking contrasts of temperature at the same instants were reported on the 5th at Valencia, 52 deg.; Loughborough, 29 deg.; 17th, Scilly, 47 deg.; Parsonstown, 22 deg.; 18th, Belfast, 47 deg.; Parsonstown, 25 deg.; 21st, Valencia, 47 deg.; Loughborough, 17 deg.; 31st, Valencia, 47 deg.; Loughborough, 20 deg.

The changes of weather during the whole month were rapid and severe. Commencing with a spell of hard frost, mild and unsettled weather followed, succeeded by storms of wind and rain. On the 3rd at Kew the ground thermometer registered 15 deg. The frost disappeared on the 4th. Between the 7th, 9 P.M., and the 8th, 9 A.M., the barometer fell from from 29.5 to 28.5. Rain began about 3 A.M., and the wind at the same time increased its force with rapidity, so that at 9 A.M. its velocity attained some 43 miles per hour. Between 8.30 and 9 A.M. occurred a sudden shift of wind from S. to W. with a heavy squall of hail, during which the temperature fell about 7 deg., but rose again. The wind was boisterous throughout the day, reaching 50 miles per hour. On the 6th, at night there was a violent storm over North Wales, with snow, and during the 7th a heavy snowstorm over North Scotland. Probably the greatest barometrical depression on record for these islands, occurred on the 8th and 9th. As regards the force of wind, much more destructive storms have happened, although this was very severe. Its centre passed from the north of Ireland to the Firth of Forth and over the North Sea.

Lower atmospheric pressures have been recorded at London, but on this occasion 28.30 was registered at Camden Town on the 9th, 5 A.M. Another cyclonic disturbance followed the same track during the 11th and 12th. The weather then became cold and frosty, wind N.E. to N.W., with heavy snow in Scotland. During the 14th and 15th a cyclonic disturbance passed ever the southern portion of these islands. At 8 A.M., on the 22nd, a cyclonic centre lay over northern Ireland, where it broke into two depressions, one of which disappeared to the northward of Scotland, and the other, after moving south-eastwards to Holland, passed in a north-easterly direction to the Baltic. After a few mild, though rainy, days, with a little snow in places, steady rain set in on the 26th, followed by snow, which settled thickly over south England; London had about 8 in. to 10 in. of snow, Southampton over a foot, many parts much more. The snow extended to Bournemouth, but none fell at Eastbourne or Hastings. The largest amounts reported at any individual stations for the rain and snowfall of the 26th were 2.88 in. at Southampton (in nineteen hours), and 2.46 in. at Stowell. At the latter station as much as 1.96 in. was yielded by the melted snow alone. At Plymouth 1.8 in. of rain fell between noon and 6 P.M. during a gale from the north-eastward. During this snowfall the centre of a deep depression travelled quickly at the Channel, giving very strong winds and gales to the southern parts of the kingdom. The destruction of telegraph wires by the adhering snow was a notable characteristic of this storm.

At Kew, the morning of the 26th was frosty; about 9 A.M. rain commenced and fell almost continuously until 6 P.M., when it turned to snow, the wind having meanwhile backed from W. through S. to N.E., with a progressive increase of force. Snow fell all through the night, and measured 8 in. deep, the rain gauge yielding next morning 1.27 in. of rain and melted snow. On the 25th there was six hours' sunshine at Kew.

Estimated from the notations of the weather, the sky was overcast between 18 days in the south and 11 in the central district; clear between 12 in the east and 4 in the north. It has been seen that the cold was most severe in the east. The clear sky favoured loss of heat by radiation during the long nights, which was not compensated by the short sunshine, though these figures indicate relatively more sunshine in the east than elsewhere. The actual returns of bright sunshine for the five weeks ending January 3, estimated in percentage of its possible duration, give 25 for these islands as a mean for all the stations, north-east England 33, south-west England and Channel Isles 31, south England 29, east England 28, central England 26, east Scotland 25, south Ireland 24, west Scotland 23, north-west England 22, north Scotland 14.

PITTSBURG.

THE two great factors in the commercial prosperity of a district are the character of the inhabitants and the natural advantages of the locality. Given a skilful and enterprising race, living in a country well situated either for trading or manufacture, it is certain that they will accumulate wealth. Now both these conditions are found in no ordinary degree at Pittsburg. The inhabitants belong to the shrewdest and most pushing race on the globe, and have the advantage of the accumulated skill of several generations, and of the reputation which always attends success. They are located in the middle of a rich mineral region which not only teems with coal and iron, but also spouts forth oil and gas and salt in a way which renders it one of the wonders of the world. It is covered with splendid forests, and is watered with majestic rivers, which provide it with power and means of transport. With such surroundings it needs no laboured explanation to account for the rise of Pittsburg, and no prophetic insight to foretell that a great future awaits it. It is the heir of wealth which will last for many generations, and the extent of which cannot be computed. Originally the coal and iron of the district seemed sufficient to provide for an enormous population; then the oil was discovered, and burst forth with a furious copiousness which unsettled the public mind, and gave rise to a tide of speculation which overran the entire country; finally, as if Nature could put no bounds to her benevolence, it was found that the earth contained an immense store of combustible gas available as a universal source of light and heat, and ready to be employed for melting iron, heating forgings, generating steam, for warming, cooking, lighting, and all the purposes to which coal has hitherto been applied. What the future contains for Pittsburg no one can tell, but for the sake of our descendants, for those on whom it will fall in years to come—when improved means of communication have practically reduced the dimensions of the globe, and the great Western States of America no longer offer a continually widening market—to maintain the commercial status of the British Empire, it is devoutly to be wished that the last surprise has been evolved from this Pandora's box, and that for the future Western Pennsylvania may be content with the advantages it already enjoys.

The resources of Pittsburg and the vicinity are so numerous that it would take columns to describe them at length, and we must, therefore, content ourselves with a brief summary. We will commence with the geographical situation. The city is due west of Philadelphia, and almost west of New York, from both of which cities it is distant between 300 and 400 miles. But although comparatively so near to the Atlantic, it is yet in the Mississippi watershed, lying at the confluence of the Allegheny and Monongahela rivers, which fall into the Ohio. This latter connects with the Mississippi, and the two provide access to a million square miles of country, and through the Gulf of Mexico to the South American continent. Although 2000 miles inland, measured along the waterway, Pittsburg is a port, and at certain times in the year, when the rivers are full can be reached by vessels drawing 20 ft. of water. But although the mountains prevent direct water carriage between Western Pennsylvania and the Atlantic, the great lake system, which is but 150 miles distant, presents an outlet both eastwards and westwards. The railway facilities rival those offered by the rivers. The Pennsylvania Railroad, the Pittsburg and Erie, the Pittsburg Division of the Baltimore and Ohio, and Allegheny Valley, the Pittsburg, Fort Wayne, and Chicago, the Pittsburg and Cleveland, and the Pittsburg, Cincinnati, and St. Louis Railways, besides others, all aid in carrying material and manufactures to and from Pittsburg. The competition of these lines is a guarantee of moderate rates, while the number marks Pittsburg as a distributing as well as a producing centre.

The city is situated in the heart of the bituminous coal formation of the Appalacian field, an area of supply which is estimated at 15,000 square miles. It does a large coal trade with the States, to which access is had by the Ohio, the mode of transport being peculiar, and being technically known as "towing." The method employed is, however, far from what would be expected from the name. Ten to fourteen barges, coal boats and flats, and one to four boats filled with bunker coal for the trip, are securely lashed together and placed in front of the so-called tow-boat, with the exception of two, which are ranged alongside of it. This floating island, carrying 24,000 tons of coal is propelled and guided by the tow boat down the Ohio, and often as far south as New Orleans, going with the flood current, which runs from eight to ten miles an hour, sweeping round the bends, past the bridges and through the narrow channels until it reaches its destination. In the season eight or ten of these cargoes will leave Pittsburg in a day. The coal comes almost entirely from the collieries in the pools of the Monongahela river. There are about sixty-six firms at work getting coal on the river, their combined output being about 100,000,000 bushels per annum, or 4,000,000 tons. On the Pittsburg, Cincinnati, and St. Louis Railway, and Chartiers branch, there are sixteen collieries; on the Baltimore and Ohio Railroad and on the Youghiogheny river, fourteen collieries; on the Pennsylvania Railroad, six collieries; on the Allegheny river, six; and in and around the city of Pittsburg eight collieries. Besides these are a number of mines not yet fully developed. Coke is made in the Connellsville field, which is near Pittsburg, and measures sixty miles by three miles. Here is a bed of coal from which there is produced a coke famous all over the States, 4,000,000 tons of it being consumed annually. There are engaged in the manufacture 10,788 ovens.

But it is not so much with coal as iron that the name of Pittsburg is associated. Throughout the counties embraced in the bituminous coal region there are to be found extensive beds of iron ore, and there are equally large deposits in the counties east of and lying along the bases of the Allegheny Mountains. The irons of the celebrated Juniata region are close to Pittsburg, while to the west there are those of Eastern Ohio. The rich ores of Virginia will be accessible on the completion of the Pittsburg, Virginia, and Charlestown Railroad, while the ores and iron of Lake Superior and the Missouri can be brought by water carriage. A blast furnace was erected in Pittsburg in 1792, but had a career of only two years. It was not until 1859 that the second furnace was built, but since that date eighteen others have been erected, varying in height from 62 ft. to 87 ft. There are also five furnaces in the neighbourhood, the aggregate annual output of the whole being 922,000 tons. Besides these there are thirty-five iron rolling mills, employing over 18,000 hands, and occupying 138 acres of land. They work up 670,000 tons of metal per annum into merchant bar, hoop, boiler plates, pipes, nails and rods. Steel is also made in large quantities, and has a high reputation. Exclusive of Bessemer

plants and rail mills and steel casting works, there are twenty-three steel works, of which eight are strictly devoted to crucible tool steel. In the Bessemer trade there are three 10-ton converters, three 7 tons, three 5 tons, and two 2-ton converters, and these, it must be remembered, are much harder pushed in good times in America than in this country, owing to the system on which royalties are paid. In 1885 the output was over 300,000 tons.

But the crowning glory of Pittsburg is its natural gas. Other lands have abundant coal and inexhaustible ore, but nowhere else are these associated with a vapour fuel which flows freely from the earth, and can be used without preparation, and apparently without stint. Its use has perfectly revolutionised the city, and has converted one of the grimiest places in the world into a comparatively clean town. The economies it realises are difficult to learn, but in one steel plant it has been found that 40,000 dols. worth of gas did the work of 96,000 dols. worth of coal, with an attendant saving of 12,000 dols. in the transport of ashes, and of 25 per cent. in wear of the furnace, At a glass factory the gas has reduced the fuel expense by 6000 dols. a year. At an iron works with nineteen heating furnaces, the saving is put down as 6500 dols. in fuel, 2600 dols. in transport, and 4100 dols. in repairs. The saving due to reduced oxidation is also great. The general opinion is that the saving in fuel cost is possibly 50 per cent., and the increased yield 15 to 25 per cent. There is also a distinct gain in quality of the metal due to the absence of sulphur, and the terms "gas iron" and "coal iron" are beginning to appear in the market. The gas district appears to lie entirely within thirty to forty miles of Pittsburg, and the greater part of the wells are within twenty miles. The supply shows no signs of exhaustion. In the Murraysville district, which may be likened to a pepper-bottle, so thick are the wells, a shaft sunk by the People's Company in December, 1885—ten years after the first Murraysville well—exhibited the strongest flow ever seen in the district; and the original Murraysville well, although it has been blowing for ten years, is said to be as strong as ever. The gas was first used in Pittsburg as manufacturing fuel in 1875-6, but its general adoption only dates from July, 1884, a fact which shows that great doubts were felt as to its permanence. At that time Mr. George Westinghouse, Jun., organised the Philadelphia Company for the supply of gas fuel. At the present time 3000 families, 34 iron and steel mills, 60 glass factories, and 300 smaller factories and hotels are using the gas. There are laid 336 miles of pipe, of which 66 miles lie within the city. Of this pipe 10 miles are 24 in. in diameter; 7 miles are 20 in.; 6 miles are 16 in.; 11 miles 18 in., and 14 miles 8 in.

Of the minor features of Pittsburg we cannot write, but those who are interested in them, can find much information in "Pittsburg's Progress, Industries, and Resources," by Mr. Geo. H. Thurston, of that place, to whom we acknowledge our indebtedness for many of the facts mentioned above. We do not find, however, that he, or indeed any American author, is quite frank in presenting the facts which tell against the credit of this favoured city. He admits that it is grimy and black, and that it is exclusively a manufacturing place, devoid of beauty, but he does not tell us that its municipal and sanitary affairs are in a state which would raise a perfect storm of disapprobation in this country. The city council is practically bankrupt, and all improvement is stopped for want of funds. Some years ago the authorities thought to do great things for the citizens without any additional taxation. They therefore bought land and waited for the rise, hoping to clear a handsome profit. But some one brought the matter before the courts, who decided that it was beyond the competence of the council to speculate in lands, and the lots had to be resold at a bad time, with the result that now the city is saddled with a debt, which consumes much of the rates. The limit of taxation allowed by law has been reached, and the consequence is that the place is left without many of the necessities of civilised life. There is no main drainage, and the use of cesspools is almost universal. Every one gets rid of his sewage in the easiest way, and often this ends in the ground becoming thoroughly soaked and poisoned. The paving of the streets is execrable, and is made worse by being constantly broken up to lay the natural gas mains, when there is no effective control to oblige the companies to put it into good order again. We merely point out these facts to show that Pittsburg is not perfect. We have no doubt that in a few years all these blots will be removed, and its domestic concerns will be put in a condition befitting its manufacturing position. It is no boast for a city to be wealthy, if it is not at the same time clean.

NOTES.

Motive Power for Submarine Boats.

The submarine torpedo boat Peacemaker, which was built from the designs of Professor J. H. L. Tuck, of San Francisco, for the Submarine Monitor Company by the Delamater Iron Works of New York, and which made a very successful run in New York Bay on November 23, performing a number of interesting evolutions on the surface, and also at a depth of 45 ft. below the water level for some time, was originally fitted with an electric motor for propulsion. This, however, for some reason proved unsatisfactory, and was replaced by a soda condenser boiler of the Honigmann type, supplying steam to a vertical 14 horse-power Westinghouse engine. The Peacemaker is a boat which may be described as nearly cylindrical with rounded-off ends; she is 30 ft. long, 8 ft. beam, and 7 ft. depth, built of $\frac{3}{8}$-in. plate. The vertical boiler is placed nearly astern; it is 4 ft. in diameter, 6 ft. high, and is fitted with 120 Field tubes $1\frac{3}{8}$ in. in diameter, and 4 ft. long. It is stated that a charge of 1500 lb. of caustic soda of 95 per cent. saturation will propel the boat for five hours. On the trial above referred to, the boat was run below the surface at a rate of 8 knots an hour, the propeller making 350 revolutions per minute with steam pressure of 100 lb., the engines indicating about 50 horse-power. There is no doubt that owing to the absence of smoke and exhaust steam, the soda condenser boiler seems admirably adapted for torpedo boat service in general and submarine navigation in particular, and we learn from Mr. Honigmann that the difficulties previously experienced in consequence of the corrosion of iron boilers when used with his system, has been lately entirely overcome by the use of specially prepared copper, and with this new introduction the Honigmann system bids fair to come into more general use. The American patents are in the hands of the Submarine Monitor Company, who intend to work them energetically.

The Russian Coal Trade.

The Mining Conference of South Russia is insatiable. In 1883, in response to its clamour, the Russian Government imposed a duty of 2 copecks gold per pood on English coal, which previously had entered the Russian ports of the Black Sea free of duty. This not contenting it after a while, the Government yielded to the fresh agitation last summer, and raised the duty to 3 copecks gold per pood. This also has failed, after a month or two, to give satisfaction; and accordingly at the recent meeting of the annual Mining Conference at Kharkoff, a fresh demand is made that the duty shall be raised to 4 copecks gold per pood, or nearly 7s. a ton. But this was not enough. To improve its own business the coal trade of South Russia demands that the Government should still further handicap the sister iron industry, which is greviously in need of cheap coal, and yet coolly asks that the duty which, in the interest of the iron industry, is imposed on foreign-built steamers imported into Russia should be waived in its own case, so as to allow the coal mine proprietors of the Donetz Valley to send their coal more cheaply to Odessa. The Russian iron trade may be expected to look after its own interests in opposing its demand; but there is another, in which England is more deeply interested, the Mining Conference demanding that the 4-copeck duty shall not only be imposed on English coal imported into Russia, but also on the bunker coal of foreign steamers entering Russian ports. If the Russian Government accede to this request, which we doubt, the coal trade may benefit a little, but the Russian corn trade will be completely smashed. However, the conference dutifully submits to the Government that it only wants the 4-copeck duty "imposed for a little while." "As soon as Russian coal can undersell English coal at Odessa we shall be ready to accede to the whole duty being taken off, so as to permit of free trade in the Russian and English coal competitions." How kind!

Another Advance of Liquid Fuel.

Liquid fuel has made during the last few days a fresh advance in European waters, the sailing vessel Protektsia, fitted with tanks, having arrived at Odessa with 300 tons of petroleum refuse, which was at once purchased for various Russian factories there, hitherto using English coal. The consignment was from the Caucasus port of Novorossisk, where petroleum refuse has been selling for some time past at about 18s. per ton. As, by means of the Russian furnaces in use, a ton of oil refuse goes as far as two tons of English coal, the latter is altogether out of the running at Odessa; and we may expect, in consequence, to see a considerable development of the new enterprise. We ourselves, in discussing the future of liquid fuel, have always expressed the opinion that its use would spread gradually from the Caspian to the Black Sea, and thence to the Mediterranean and the East, in advance of any sudden and sweeping success at home prognosticated by enthusiastic inventors in this country. Up to now this view has been justified by events. Liquid fuel has made very little headway in England, where it has to compete with cheap coal, while it has not only been adopted by a number of vessels running between Batoum and Odessa, at both of which ports coal is dear, but has at length been adopted also by factories at Odessa. In all probability, now that a start has been made in conveying oil refuse in bulk in the Black Sea the enterprise will extend, and before long successors to the Protektsia may be conveying it to Mediterranean ports. The fact that the Russians should have made this start themselves shows that they are not dependent upon English capital and enterprise in this matter. Novorossisk is the outlet of the Black Sea petroleum fields, and now that the railway through them is nearly finished a copious supply of oil is becoming available for steamers. A telegram to the *Kavkas* states that of the two tunnels delaying the opening of the line, one is finished, and the other will be completed by April. The railway will then be finished throughout, and English coal will experience a formidable rivalry in the Black Sea region. It is unnecessary here to discuss which will prove the better fuel, the fact remains that the Russians prefer petroleum fuel to English coal, and that the use of liquid fuel is making rapid headway in South-East Europe.

Carron Works Award Scheme.

Stimulated by the very marked success which, during the past few years, has attended the award scheme instituted by Messrs. William Denny and Brothers, Leven Shipyard, Dumbarton, the authorities at Carron Iron Works resolved in the early part of last year to make an effort to do likewise. At a meeting held on 28th ult. in connection with the Carron Science and Art Classes, Mr. T. D. Brodie, the head of the old-established concern, made a statement regarding the results that had been attained in their first year of effort. He stated that the Committee appointed to manage the Carron award scheme had had the satisfaction of considering eighteen claims for awards. Of those claims, eleven had been from workmen employed in the various workshops, and the remaining seven were by employés in the offices. Such a large proportion of claims for the workshops proved the interest which many of the workmen were taking in the scheme, and in the opinion of the Committee it only required time to make the interest more general, and to stimulate the men to further exertion in the way of improvement. Of the eighteen claims considered by the Committee five were adjudged worthy of awards, which were accordingly granted. That represented not less than nearly 28 per cent. of the whole number of claims tabled, and which adjudicators were inclined to think quite satisfactory. The values of the awards were: 1*l.*, 2*l.*, 2*l.*, 1*l.* 10s., 1*l.* 10s. respectively, or a total value of 8*l.* Of the five awards, one went to the offices and four to the workshops, showing that the claims of the workmen, as a whole, were most deserving of merit. The successful claimants were: James Fenwick, grate fitter, awarded 1*l.* for an improved self-locking tram truck attachment; John Malloch, draughtsman, awarded 2*l.* for his design of a trunnion steam expansion joint; John Peebles, pattern shop, awarded 2*l.* for his proposed method of hollowing out wood by circular saw; George Mitchell, forging shop, awarded 1*l.* 10s. for an improvement in the formation of certain dies; John Watson, boilermaker, awarded 1*l.* 10s. for an improved spring cress. With a view to increase still further the interest of the workmen in their work, and to develop the talent which must exist among

such numbers of men, the Committee now propose to offer awards of 5*l.*, 3*l.*, and 1*l.* respectively, to those workmen who shall, during the present year, prepare and submit the best papers on "range construction," or such apparatus or appliances as are used for the baking of meat, roasting of meat, baking of pastry, &c., if the papers shall be adjudged worthy by the Committee.

The Camel Helping the Iron Horse.

In many parts of Asia the railway has superseded the camel, but we believe that the incident that we are going to describe is the first instance of the camel coming to the aid of the railway. Before the last Turkish war a large caravan trade existed between Batoum and Persia, *vid* Transcaucasia, the Russians allowing European goods to traverse their dominions duty free. On the completion of the railway from Tiflis to Baku in 1883, however, the Emperor, in order to further Russian trade, abrogated the privilege of free transit, and most of the camels were sent by their owners to Turkey, to carry the goods by caravan from Trebizond to Tabriz. The result of this evacuation of European commerce from Transcaucasia was the temporary absence of any extensive traffic on the railway from Tiflis to Baku. Before long, however, the petroleum traffic began to develop, and ever since has mastered the powers of the rolling stock so completely that every time hundreds of tank cars have been added, the traffic has proportionately expanded afresh. In the mean time Europe, finding the Transcaucasian Railway better than the Trebizond caravan road, has reverted the Persian trade to the old route again, and now Persia is sending west so much produce *vid* Baku that, to help the railway, caravans of camels have been put on the postal road to run to Tiflis and Batoum. Now that the Transcaspian Railway is finished to the Oxus, large quantities of goods are beginning to pass over the Baku-Batoum line to and from Central Asia. Thus, if the petroleum traffic were removed entirely from the line, the ordinary goods traffic would employ to the fullest the resources of the railway. This is a circumstance we would recommend for consideration, in the first place, to those narrow-visioned politicians who fancy Russia is getting more and more into the mire by building railways in Asia, and, in the second, to the members of the London Chamber of Commerce who expressed the curious opinion at Colonel Stewart's recent lecture, that the junction of the Russian and Indian railway systems would be unattended with any traffic over the Afghan line. Colonel Stewart and Mr. Charles Marvin combatted strongly this opinion, and the latter asked the very pertinent question that, if the Baku-Batoum Railway, which simply connected the six millions of Persia with Europe, had almost reached its limit of traffic capacity in less than three years, might not similar success attend the completion of a railway which would connect the 300 millions of India with the whole railway system of Europe? He could hardly have been aware of the camel incident, or he doubtless would have quoted it with effect before the incredulous London merchants attending the lecture.

Destruction of a Standpipe.

The use of erect iron towers for regulating the pressure of public water systems has been largely increased in American practice during the past few years. They occupy a place midway between the hand-to-mouth system of pumping directly into the water mains, and on the other hand of using a reservoir on elevated ground. For small water works their economy has been well established, while for water supplies to towns unaccompanied by any hills of sufficient elevation to furnish a site for a distributing reservoir, these standpipes are certainly preferable in every respect to a direct pumping system. Of late years the standpipes of small diameter have been modified into towers measuring 20 ft. to 40 ft. in diameter, and capable of containing a night's supply, and thus relieving the system of continuous or night pumping. A steel standpipe erected for the purpose of supplying water to the well-known pleasure resort of Coney Island, near New York city, was built 250 ft. high and 16 ft. diameter at the base; at the height of about 90 ft., the diameter gradually diminished to 8 ft., which was continued to the full height. The tower was held in a vertical position by numerous steel guy ropes. It was built of tank steel, of a tensile strength of 68,000 lb., although the contract demanded only 60,000 lb. Beginning on a foundation of concrete, the lower courses were built of steel plates $\frac{7}{8}$ in. thick, and as the elevation increased, thinner plates were used, until at the upper portion their thickness was reduced to $\frac{3}{8}$ in. The standpipe had been filled twice, until water flowed over the top without showing any indications of weakness; but during the process of filling it on a later day, when the water had reached to an elevation of 225 ft., the lower portion of the tower violently ruptured, and the upper portion, according to the testimony of numerous eye-witnesses, appeared to poise for a moment in mid-air before falling to the ground. The exact cause of the accident is a matter of dispute, and probably will never become known, except through conjecture, but the tower undoubtedly broke upwards, beginning at the lower corners. The area of the bottom being four times greater than that of the top there was an upward thrust of the water at the conical portion, which amounted to 700 tons, and the tower weighed 200 tons, so that there was an upward thrust of 500 tons, tending to pull the shell from the bottom of the tower. By the advice of an engineer called in by the builders of the tower during construction, attention was called to this upward thrust, and inside diagonal braces were put in, but it is probable that there were not enough of them to withstand any irregular distribution of stress caused by yielding of the foundations.

French Academy Prizes.

The extraordinary prize of 6000 francs offered by the French Academy of Sciences for progress tending to increase the efficacy of the French Naval Forces has been in a measure awarded to M. Fleuriais for the gyroscope-collimator; 4000 francs having been set apart for him. The remaining 2000 francs have been awarded to M. De Bernardières, whose researches in terrestrial magnetism and their application to cartography, have done much in the direction set forth by the title of the prize. The Montyon "mechanics" prize was awarded to M. Rozé, of the Ecole Polytechnique for his memoirs on mechanics; and a Plumey prize was bestowed on M. De Bussy, inspector-general of marine engineering, for his naval engineering services, especially in improvement of the French fleet. One of these improvements is the introduction of soft steel in naval construction. The tenacity of the steel employed surpasses that of iron, but is inferior to that of hard steel. Moreover, its power of elongation is greater than that of hard steel; and its quality little subject to temper while having, either cold or hot, a great ductility. M. De Bussy has constructed eight *cuirassés*, four torpedo cruisers, four big gun *cuirassés* of 1639 tons displacement, and four torpedo cruisers expected to realise a speed of 17 knots an hour. The value of the prize is 2500 francs. A Lalande prize has been awarded to M. Backlund, of Poulkowa, for his recent work on the movement of Encke's comet. He has found that the acceleration of the average movement is diminishing, and is now about half what it was from 1819 to 1865. The Valz astronomical prize has been given to M. Bigourdan for his observations on comets, nebulæ, and double stars. The great prize of mathematical science has been reserved for further competition in 1888, only one memoir having been offered on the stated subject, namely, "The Perfecting of the Theory of the Application of Electricity to the Transport of Power in some important Point." Many other prizes on other branches of science were awarded; and the following among other prizes have been proposed for 1887 and the years following to 1891. In 1888 a prize of a gold medal of 3000 francs value is offered for the perfecting, in some important point, the theory of the movement of a solid body. Another extraordinary prize of 6000 francs is offered for progress tending to increase the efficiency of the French naval forces. The memoirs must be lodged with the secretary of the Institute before June 1 next. A Fourneyron prize of 500 francs in *rentes* will be offered for a study of progress in aërial navigation since 1880. A medal of 3000 francs value will be offered for the perfecting, in some important point, the theory of the application of electricity to the transmission of power. The memoirs must be lodged with the secretary before June 1, 1888.

The Union Storage Battery.

A new battery is being shown by the Union Electrical Power and Light Company, of 127, Cannon-street, London. It is an accumulator having plates of spongy lead and peroxide of lead respectively, and differs from previous batteries of the same type in the feature that the peroxide stands alone without the support of any backing, core, or grating. This plate can also be prepared and kept perfectly dry until it is needed, so that spare elements may be held in readiness, and those which are spent be removed from the cells and be sent to the dynamo to be recharged. By this arrangement the labour of renewing batteries, which are not in connection with a dynamo machine, is greatly reduced. The cells, as made at present, contain thirteen plates, and measure 11 in. by 6 in. by 7 in. deep. The weight is 20 lb., and the storage capacity 115 ampère hours. The electromotive force is over two volts on open circuit, and at the company's offices there are to be seen twenty cells feeding fifteen glow lamps of ten candle-power, and fifteen cells feeding twelve lamps of similar power. It is claimed that an increase of over 50 per cent. in the relative amount of work to weight is obtained over other lead batteries, while the following table is also put forth as a basis of comparison with primary batteries. The Union battery gives 5 ampère-hours per pound of weight:

Holmes-Burke	1.86
Daniell...	1.5
Fuller (medium size)...	1.02
Leclanché (medium size)	1.0

The company observes considerable reticence as to the method of producing the peroxide plate. It appears, however, to consist of the lithanode which was mentioned by its inventor, Mr. D. G. Fitzgerald, at the last meeting of the British Association, and extolled by him as the coming material for batteries, although he declined to give any clue as to its nature, and confined his remarks entirely to its merits, a proceeding which naturally created a feeling of resentment in a scientific gathering. It is formed of a mixture of litharge and 5 per cent. of inert matter, such as earthenware, ground pumice, or kieselguhr. To this is added a salt formed of ammonia and an acid, which when set free by the decomposition of the salt will combine with the oxide the lead, and form an insoluble or nearly insoluble compound with that metal; such salts are the sulphate, phosphate, chromate, tartrate, and oxalate of ammonia. The mixture is placed in a mould, and is subject to a jet of steam carrying a little glycerine with it. This hardens the surface, and at the same time dissolves the salt and brings about the reaction. When this is complete the plate is put away to dry, and is then "formed" by the current in the usual way. The porous lead plate is similarly prepared, but its conductivity is increased by longitudinal strips of pure lead. Both plates are fixed in frames of celluloid, which prevent contact in the cells. The company states that it is calculated the lamps that are exhibited are maintained at one-sixteenth of a penny per lamp-hour; we should like to know how the calculation is made, for it is certain that lamps driven direct from a dynamo cannot be maintained at this rate, and the intervention of a battery will not decrease the cost. We understand that the Union cells are giving great satisfaction at the Post Office, and there is certainly a wide field for a battery which can be easily renewed, and does not produce sulphate of zinc.

Atlantic Liners.

The details of times occupied in carrying and delivering mails by various Atlantic steamers, which have been collected by the United States Superintendent of Foreign Mails, and an abstract of which has been published in the *Times*, come opportunely in view of the public interest recently aroused by the re-arrangement of mail contracts. The figures are divided into seven groups according to the routes taken, and, although an English line heads the list with regard to maximum speed, the German and French vessels of what may be termed the first speeds are more numerous than our own; so much so, that if the choice lay between our own and foreign steamers—irrespective of route—it would appear that the foreigners should have the preference. The following are the chief figures, as given in the *Times*, from the statement of the Foreign Mail Superintendent, Mr. Nicholas Bell:

From New York to Queenstown, 2820 nautical miles: Cunarders (each three trips).—The Aurania, 15.6 nautical miles per hour; the Bothnia, 13.4; the Umbria, 16.8; the Etruria, 17; the Servia, 15.8. Guion liners (three trips).—The Alaska, 16.3; the Arizona, 15; (one trip) the Wisconsin, 11. White Star Liners (three trips).—The Germanic, 14.9; the Celtic, 13.4; (two trips) the Britannic, 14.5; the Republic, 13.8. The National liner America (five trips), 15.7. Iuman liners (two trips).—The Baltic, 13.2; (one trip) the City of Berlin, 13.7; the City

of Chicago, 13.3; the City of Richmond, 12.8. The Anchor liner City of Rome (two trips), 16.3.

New York to Southampton, 3192 miles: North German Lloyd's (three trips).—The Trave, 16.5; the Saale, 16.3; the Eider, 15.9; the Aller, 15.8; the Ems, 16.4; the Fulda, 16; the Elbe, 15.7; (one trip) the Werra, 16.2.

New York to Plymouth, 3062 miles: Hamburg American liners (three trips).—The Hammonia, 13.9; the Wieland, 13.7; the Lessing, 13.8; the Gellert, 13.

New York to Glasgow, 2926 miles: Anchor liners (three trips).—The Furnessia, 12.2; the Ethiopia, 11; the Devonia, 11.2; the Anchoria, 9.5.

New York to Havre, 3200 miles: French liners (five trips).—The Bourgogne, 16.4; (four trips) the Normandie, 15.5; (three trips) the Champagne, 16.8; (two trips) the Gascogne, 16.3; the Bretagne, 15.9.

New York to Antwerp, 3444 miles: Red Star liners (four trips).—The Noordland, 12; the Rhynland, 12.2; (three trips) the Westernland, 13.3.

Boston to Queenstown, 2682 miles: Cunarders (three trips).—The Cephalonia, 12.8; the Scythia, 12.8; (two trips) the Gallia, 13.9.

From these figures it will be seen that England stands alone in possessing a steamer that can maintain an average speed on the ocean of over 17 knots. We say over 17 knots because the mail officer's figures are taken and the time occupied in getting underway and clearing harbour should be deducted. This would tell somewhat against the English ships which are mostly on the shorter routes. Taking the figures as they stand, however, and striking an average, we get the following results: The North German Lloyd's heads the list with eight ships averaging 16.1 knots. The Cunard line has also eight vessels, but the average speed is only 14.8 knots, two old vessels on the Boston route bringing down the average considerably. The Compagnie Transatlantique has five vessels, and these give the highest average speed, viz., 16.18 knots. The White Star line, to which company higher speeds on the ocean is greatly due, have not been able to hold their once premier position, having but five vessels averaging 14.1 knots. The Guion line, the successors of the White Star as Atlantic champions, have but three vessels, their average speed being also 14.1 knots. The other figures speak for themselves. The whole matter of course hinges on the question of State bounties, and would seem to give the political economists a hard nut to crack.

THE SCOTCH IRON TRADE IN 1886.

IN respect of the Scotch iron trade, the past year was one of interest in several of its features, and, on the whole, 1886 may be now somewhat confidently regarded as the last of a series of years of a depression which has affected many branches of trade and industry. During the first half of the past year the depression in the Scotch iron trade caused somewhat serious financial difficulties amongst dealers in the Glasgow market, and even amongst old-established firms engaged in the production of pig iron. There were also very small shipping returns from week to week in the early months of the year, combined with a steady increase of the stocks of iron in Messrs. Connal and Co.'s public warrant stores. That increase took place even though there was a marked decrease in the production of pig iron. Then there was the disturbing influence of the General Election, which tended to retard business enterprise and speculation. When the autumn arrived, however, it was found that the slow but steady development of trade in America had begun to make itself felt in this country, evidence of which was seen in the demand for hematite, for rails, for Scotch special brands of pig iron, and for old iron material of various kinds. The Scotch market then began to improve in a material degree, and prices steadily advanced.

In the month of January the prices of warrants opened at 41s. 0½d. per ton, and with slight fluctuations they slowly declined till the 9th of March, when 37s. 11d. was recorded, which was the lowest price for the year. It even fell below the lowest price reached during the past twelve years by 2s. 1d. per ton, the lowest price in any one of the previous eleven years being 40s., which was paid July 8, 1879. It may be remembered that attempts were made to effect a combination between the Scotch ironmasters and those of the Cleveland district, with the view of reducing the production; those attempts, however, ended unsuccessfully. The continual increase of stocks of every description of pig iron in other parts of the kingdom, as well as in Scotland, combined with the unremunerative prices then ruling, became so serious that a proposal was made by certain ironmasters to reduce the make of pig iron all over the kingdom to the extent of 25 per cent. Such dealers as were oversold became quite scared by this proposal, and at once heavy buying took place at rapidly advancing prices, with the result that by March 30, as high as 41s. was paid for Scotch warrants. This scheme was also found to be unworkable, owing to the fact that the interests of the various ironmasters were very greatly complicated. It also fell through, and prices again relapsed until May 10, when 38s. 1d. per ton was accepted. Most of the Scotch ironmasters saw that it was necessary to effect some restriction of the make of pig iron, regardless of what might be done in other parts of the kingdom; and consequently a number of their blast furnaces were from time to time blown out. Special brands advanced in price until June 16, when 39s. 6d. was paid; then, during the two following months, the price ranged between 39s. and 39s. 9d., and returned to 39s. 3d. per ton. In the month of September buying was again brought on, chiefly in consequence of the labour troubles with the miners, and by the end of the month the price of warrants had reached 40s. 9d. per ton. From that date onward it was apparent that there was a general improvement of the tone of the market, as was seen by more liberal transactions taking place in special brands and hematite, especially on American account, at quickly advancing prices. The result was that a speculative movement was made in warrants, the price of which reached 43s. on October 22. This was followed by a smart reaction, and on November 10, 41s. 2d. was accepted, showing a decline of 1s. 10d. per ton in less than three weeks. Then favourable reports arose of improvement in trade, and the American demand continued, with the result that prices recovered and steadily advanced till December 29, when 44s. 7½d. was reached, and which was the highest price paid for warrants over the year. That advance took place even in face of a heavy increase in the stocks, which was shown by the returns issued on behalf of the ironmasters at Christmas. The year closed with the cash price of warrants at 44s. 6d. per ton, as compared with 41s. 1d. on December 31, 1885, and 42s. 3d. on the corresponding date of 1884. Over the year the average price was 39s. 11d. per ton, being the lowest average for the past twelve years. Owing to the labour difficulties, previously referred to, and to the restrictive policy which most of the ironmasters pursued on account of the unremunerative prices ruling, there was considerable irregularity in the production of pig iron during the year. At the opening there were 92 furnaces of all classes in blast. The number increased to 97 in the month of April, and then declined to 66 in October, increasing to 75 in November, and again declining to 66 in the first week of December, the number at the close of the year being 72, and the average over the year being 83, as against an average of 90 in 1885. The average number blowing in 1875 was 117, in the following year it was 116, then it fell off, and again rose to 116 in 1881, declining almost regularly during the past five years. The total production of pig iron last year was 935,801 tons, as compared with 1,003,562 tons, in the preceding year, showing a decrease of 67,761 tons. During the past twelve years the total make has on five separate occasions been under 1,000,000 tons, the lowest being 902,000 tons, in 1878. The greatest make in any one of those twelve years was 1,176,000 tons, in 1881. With the restriction in the make during the past year only the larger sized furnaces were in use, as a general rule; and thus the average production per furnace per week was raised to about 216 tons, as compared with 214 tons in the year 1885. With the increasing demand for hematite pig iron for use in making mild steel, the Scotch ironmasters now find it to their advantage to employ a greater number of their blast furnaces in the production of that kind of pig iron. As many as 18 furnaces have been so employed at one time, and the average during the past year was 16, while in the previous year it was 13, and only 8 in the year 1884. It scarcely need be mentioned that the hematite pig iron referred to is chiefly consumed in the Lanarkshire steel works.

There was again a very marked decrease in the shipments of pig iron over the past year, amounting to 44,252 tons, as compared with those of 1885. The total for the year was 382,637 tons, being the lowest total for the past twelve years, the nearest approach being the shipments for 1878, which amounted to 395,528 tons. On seven separate occasions during those twelve years the shipments have been upwards of half a million tons per annum, the largest total being 641,048 tons in 1885. In respect of last year's shipments, it may be said that the falling-off was chiefly in those to Germany, Holland, Australia, and Italy. Those to the United States showed a considerable increase, being 54,660 tons, as compared with 41,692 tons in 1885. In 1884, however, they amounted to 78,788 tons, and in the preceding year to 126,720 tons. British North America also took a larger quantity than it did in 1885, but still the total was very much smaller than that of 1883.

The coastwise shipments for the year showed a decrease of 14,703 tons, and the deliveries by rail to England were 4909 tons less than in 1885. The delivery by rail to England was as much as 73,460 tons in 1875, but since then it has gone on almost continually decreasing, until it has now reached the very low total of 9950 tons.

The total consumption of Scotch and English iron during last year was 831,695 tons, as compared with 860,619 tons in the preceding year, showing a decrease of 28,924 tons. It is gratifying, however, to note that the quantity of Scotch iron consumed in Scotland was increased to the amount of 27,076 tons. Of course, that means that there was also a decrease in the amount of English pig iron used, which, in fact, was as much as 56,000 tons. On this point it may be interesting to note, that the imports of English pig iron reached their maximum—465,000 tons—in the year 1885, the lowest annual total over the past twelve years being 220,000 tons, in 1875. The decrease in the amount of English pig iron used in Scotland is now largely due to the fact that Scotch steelmakers find it advisable to use Scotch hematite pig iron. In the steel and malleable iron works, there was a consumption of 56,487 tons more than in 1885, and the consumption in the foundries was less to the extent of 29,411 tons.

At the end of the past year the total stocks of pig iron in Scotland amounted to 1,183,039 tons. This total is the largest on record. Twelve years ago the total was only 170,000 tons, and by the end of 1879 it had increased to 745,000 tons, falling off slightly in the following year, and then in 1881 increasing to 940,000 tons. During the next three years the stocks remained almost stationary, and at the close of 1885 the total was 1,050,683 tons, so that at the close of the past year there was an increase of 132,356 tons, the total being divided between the warrant stores and the makers' yards in the proportion of 665,688 tons, and 384,995 tons respectively.

In closing these remarks brief reference ought to be made to the fact that the production of basic pig iron has now become a regular branch of the Scotch iron trade. It is prosecuted with considerable vigour and marked success by Messrs. Merry and Cuninghame, at their Glengarnock Works, in Ayrshire, and by the Glasgow Iron Company, at their works at Wishaw, Lanarkshire. As our readers may be generally aware, the manufacture of basic steel by the Thomas-Gilchrist process is successfully conducted at both of those establishments. It is also worthy of remark that the Scotch blast furnaces are now more universally worked on the close-topped system than at any former time. This is an attempt to bring down the cost of production to the lowest possible level, and certainly the adoption of the system in question has been attended with very marked economy. Of course, it is scarcely necessary to inform our readers that the fuel used in the Scotch blast furnaces is raw coal, chiefly, if not entirely, of the kind known as splint coal, which possesses great "bearing" powers. The resulting gases, where close-topping is had recourse to, are extensively used in getting up steam and in heating the blast. In at least three of the iron works the gases are also made to give up their tar, creosote oil, and ammonia; and thus there is now being established an important chemical industry side by side with the manufacture of pig iron. Eventually, this may result in still further economy, but in its initiation it has been attended with a very considerable pecuniary outlay, and much misdirected experimental effort. One of the most recent endeavours to effect economy in the production of pig iron in Scotland, has been the adoption of regenerative hot blast stoves, the use of which has been highly successful. Such stoves, however, are the exception rather than the rule at the pig iron establishments in Scotland.

QUEENSLAND COAL.—A seam of coal 9 ft. thick has been struck at Swan Creek, five miles from Warwick, where sinking has been carried on for some months past. The coal is said to be of first-class quality.

AUSTRALIAN DEFENCES.—It will be remembered that, after many preliminary negotiations, the premiers of Victoria, New South Wales, and Queensland met Admiral Tryon last April in Sydney, to confer on the subject of the naval defences of the colonies. The conference had before it a memorandum written by the Admiral, December 24, 1885, specifying a scheme approved of by the Admiralty. In that memorandum it was assumed that the colonies would continue to maintain their respective local defence forces. An increased sea-going fleet being requisite, however, it was proposed that one should be provided, equipped, and maintained at the cost of the colonies, and should be retained in Australasian waters. These vessels would be supplied and manned by the Admiralty, at the expense of the colonies. In the opinion of the Admiralty, five "cruiser-catchers" of the Archer class, and two fast sea-going torpedo vessels would be required to make the squadron on the Australian station reasonably strong. The Archer cost about 106,486*l.*, the annual maintenance being 25,456*l.* It was estimated, further, that the required torpedo boats would cost 46,729*l.* each, the annual maintenance being 11,029*l.* The total cost of the five cruisers, therefore, and the two torpedo boats was estimated at 625,788*l.*, and the annual maintenance at 149,338*l.*, exclusive of the annual cost of exchanging crews, estimated at 3300*l.* The conference agreed that the premiers should consult their respective cabinets on the scheme. The views of these cabinets have since been ascertained, and, as was to be expected, they exhibit considerable divergencies.

CANDLE-MOULDING MACHINE.

CONSTRUCTED BY MESSRS. J. AND W. BARLOW, ENGINEERS, ROCHDALE.

Fig. 1.

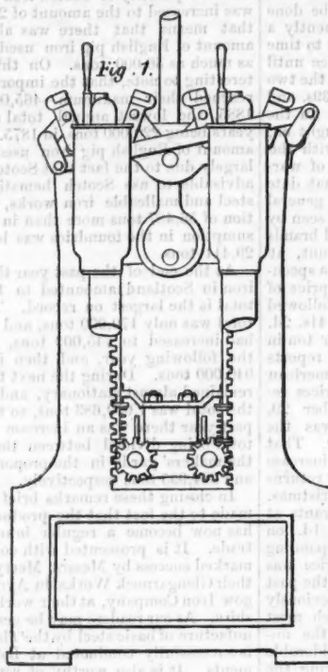


Fig. 2.

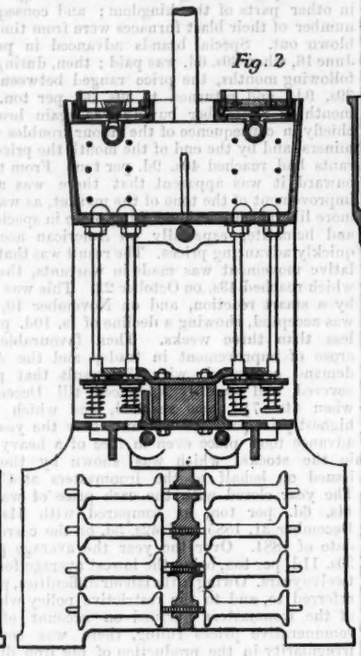
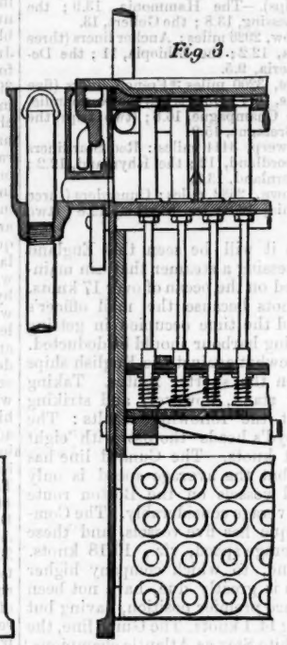


Fig. 3.



CANDLES with self-fitting ends cannot be made in a mould formed in one piece, because they taper towards each end and therefore will not draw either way. As there are practical reasons for not opening the moulds longitudinally it is customary to make the conical end pieces separate from the cylindrical portion, and detach them from the candles after the latter have been forced up by the driving board. This method involves considerable trouble and expense, and to avoid it Messrs. J. and B. Barlow, of Moss Bridge Iron Works, Rochdale, have been making for some time past the machine which we illustrate on page 12 and also above. In this the conical portion of the mould is made in two parts, divided along the centre line, and when the wax has been run, these half cones are first lifted vertically until they clear the candle, and are then separated to leave room for the candle to be pushed up between them. A simple turn of a handle returns the half cones to their first position ready for another candle. It is claimed that a saving of two shillings per hundredweight is effected by this method of operation over that in which loose cones are employed.

We have spoken of only one candle, but it will be understood that a large number of moulds are combined in one machine, and are operated simultaneously. The perspective engravings show both ends of such a machine, the right-hand view illustrating it with the moulds ready to receive the wax, and the left-hand one with the moulds open, and the candles forced into the receiving frame, which has been placed to admit them. The details of the machine are shown in Figs. 1 to 3. There are four rows of vertical moulds (Fig. 3) contained in a box, into which hot and cold water can be admitted alternately, and, working in each mould, is a piston with a hollow piston-rod, through which the wick passes from one of the bobbins below (Fig. 2). The pistons form the moulds for the tips of the candles, and also serve to push them up into the frame above. The vertical movement is effected by the driving board which is under the ends of the piston-rods, and is raised by the gearing and handle to be seen in the left-hand end view. The piston-rods are of different lengths, so that the candles are started in succession, and thus the effort is reduced. The springs at their ends (Fig. 2) serve to bring the pistons down into the bottom of the moulds.

As the two sides of the machine are alike in their construction, it will be sufficient to speak only of one in describing the construction of the conical end moulds. The two rows of vertical cylindrical moulds stand below a trough formed in three pieces, thus ⌊ ⌋. Along each toe of the ⌊ pieces, and along each side of the flat piece, there are arranged half-cones which come together and register with the tubular moulds below. The wax is poured into the trough and fills the moulds, and after the surplus has been removed the cones are opened by turning the eccentrics at each extremity of the machine. The ends of the various parts of the troughs are connected to horizontal bars joined to the eccentric rod, and rise with it. At the same time they are separated by the compound action gained by pivotting the outside members to bell-cranks centred to the frame and connected by a diagonal bar. The centre piece is also rotated 90 deg. on its axis to leave a clear passage for the candles. When pushed up the candles are received in wooden clamps which close upon and retain them in position.

We understand that these machines, which are the invention of Mr. J. J. Claret, have been made in considerable numbers and prove very satisfactory.

NOTES FROM THE UNITED STATES.

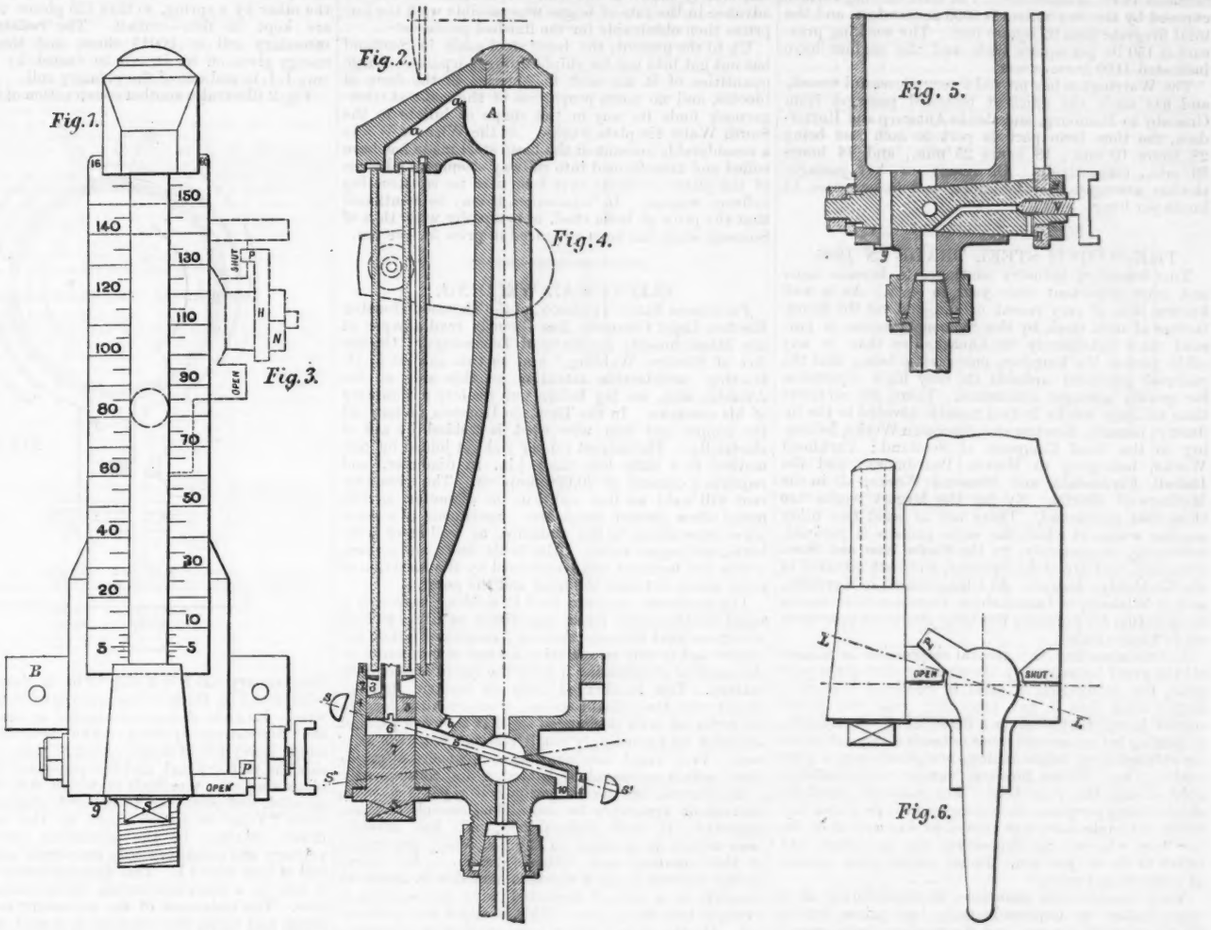
PHILADELPHIA, December 24.

THE American iron market is very strong in all branches. A further advance in prices seems probable. The leading Pennsylvania iron companies have advanced prices for standard brands of pig iron to 20 dols., and 19 dols. for Nos. 1 and 2, and 18 dols. for grey forge. Merchant bar has advanced to 2 cents; angle iron to 2.20; plate 2.40 to 2.50; steel rails to 36 dols. and 36.50 dols.; old rails to 24.50 dols. at tidewater, and all other material in proportion. To-day's probabilities are that a further advance will be forced upon the market in case there is no good occasion for it, but that buyers in all branches are anxious to save themselves against the possibility of higher prices; the belief that prices will be higher has taken possession of the American mind, and consumers are everywhere either buying or negotiating for supplies on a basis of present prices. The effect of this is, of course, to enhance values, and if no obstacle is thrown in the way, higher prices will be reached within thirty days. Some of the large pig-iron companies are proposing to put up prices of No. 1 foundry to 21 dols. Some of them are refusing quietly to sell at anything less. The bar-iron manufacturers have not yet taken action upon their card rate, but will likely advance to 2 cents for refined, and 1.90 for medium and 1.80 for common. A meeting will be held on the third Wednesday in January to decide. The eastern and western nailmakers will shortly meet to fix first upon the question of restriction, and second as to prices. The plate and sheet-iron makers have an abundance of business in hand at prices ranging from 2.25 to 2.50 for plate and tank. Steel rail makers have recently declined offers for large lots of iron as they are not in a position to fill orders at the time buyers desire. Very little capacity remains unsold up to June 30th. The business up to this time foots up 1,050,000 tons. The estimated capacity to be ordered is calculated at 1,675,000 tons. Brokers have inquiries for upwards of 100,000 tons of steel rails for shipment. They are also watching the market with a view to importing large supplies of crude and finished iron. Rail blooms are quoted at 29 dols., and business is being done on this basis. Bessemer pig is also under very active inquiry, and quotations to-day are 20 dols. to 20.50 dols. at tidewater. It is expected that within ten days foreign business in blooms, billets, and slabs will foot up 30,000 or 40,000 tons. Old rails have advanced 50 cents more and are quoted by buyers at 25 dols. and by sellers at 25.50 dols. Scrap of all kinds is very scarce, and No. 1 sold to-day at 21.50 dols. Cargo lots are held at 22 dols. to 22.50 dols.

STEEL RAILS IN GERMANY.—Tenders have just been received at Altona for 1870 tons of steel rails for the Prussian State Railways. The tender of Krupp, of Essen, was 1s. per ton below that of the John Cockerill Company.

SOCIETY OF ARTS.—The following arrangements have been made for the meetings of the Society of Arts: Ordinary meetings.—Wednesday evenings, at eight o'clock: January 19, "Cameo Cutting as an Occupation," by J. B. Marsh; January 26, "Photographic Lenses," by J. Trail Taylor; February 2, "Electric Locomotion," by A. Reckenzaun; February 9, "Adulteration of Beer," by A. Gordon Salamon; February 16, "Handicraft Training," by Henry H. Cunynghame; February 23, "Recent Advances in Sewing Machinery," by John W. Urquhart. Amongst the papers for which dates will be hereafter announced are: "Miners' Safety Lamps," by Edward H. Liveing; "Development of the Mercurial Air Pump," by Professor Silvanus P. Thompson, D.Sc.; "Machinery and Appliances used on the Stage," by Percy Fitzgerald; "Textile Fibres in the Colonial and Indian Exhibition," by C. F. Cross; "Irish Industries," by Rev. Canon Bagot; "Progress in Telegraphy," by William Henry Preece, F.R.S.; "Railway Brakes," by William P. Marshall; "The Living Organisms of the Air: the Effect of Place and Climate on their Prevalence," by Dr. Percy Frankland; "The Cultivation of Tobacco in England," by E. J. Beale. Indian Section.—Friday evenings, at eight o'clock: January 21, "The Upper Oxus," by Trelawney Saunders; February 11, "The Economical Condition of India," by Dr. Watt, C.I.E.; March 4, "Our Trade Routes to the East," by Major-General Sir F. J. Goldsmid, K.C.S.I., C.B.; April 29, "Village Communities in India," by J. F. Hewitt. Foreign and Colonial Section.—Tuesday evenings, at eight o'clock: January 25, "New Zealand Scenery," by Kerry Nichols; April 19, "South Africa," by Major-General Sir Charles Warren, G.C.M.G. Those papers for which dates have not yet been fixed are, "Fiji," by James Mason, C.M.G.; "The West Indies," by Sir Augustus Adderley, K.C.M.G.;" "Australian Wines," by Richard Bannister. Applied Art Section.—Tuesday evenings, at eight o'clock: February 1, opening address on "The Present Condition of Applied Art in England, and the Education of the Art Workman," by T. Armstrong, Director of the Art Division, Science and Art Department; February 22, "Wrought Ironwork," by J. Starkie Gardner, F.G.S.; March 15, "The Application of Gems to the Art of the Goldsmith," by Alfred Phillips; April 26, "Ornamental Glass," by J. Hungerford Pollen; May 24, "The Importance of the Applied Arts and their Relation to Common Life," by Walter Crane.

ALLAN'S PRESSURE GAUGE.



THE air-spring pressure gauge of Mr. Alexander Allan has now been before the public for a number of years, but it has scarcely met with the recognition it merits. This is no doubt to some extent due to certain inconveniences attendant upon its use in its earlier forms, but from time to time its inventor has materially improved its details, and we annex engravings showing how it is now constructed. In Allan's air-spring pressure gauge the index is formed by a column of water in a graduated glass tube. This water is acted on at one end by the steam pressure, while above it there is a body of air which has no means of escape. When the boiler, to which the gauge is applied, is cold, the air stands at atmospheric pressure, but when steam is raised the water is forced up the glass column, driving the air before it and compressing it, the pressure in the gauge tube being always equal to that in the boiler. If the whole of the air were contained in a parallel tube the variations of the water level would grow steadily less for equal increments of pressure, and at high pressures the scale would be very minutely divided, unless the tube were of a most inconvenient length. In the time of Watt, when the air gauge was first introduced, a parallel gauge answered well enough, but now it needs to be supplemented by a tapered vessel of such a form that equal increments of pressure cause equal rises in the water level. The shape of the vessel employed by Mr. Allan is clearly shown in Fig. 2 annexed. Water, produced by the condensation of steam in a long syphon pipe, having twice the capacity of the gauge, enters at the bottom, dividing itself between the glass tube and the vessel behind it. As the water rises part of the air is driven into the narrower part of the vessel, and this renders the lower divisions of the scale much shorter than they otherwise would be.

As we have said, considerable improvement has been lately made in the manufacture of this gauge, and the details have also been modified. The screw which closes the top of the air vessel is now brazed in its place, and thus all chance of air leakage at this point is abolished. The plug is provided with a little screw valve V (Fig. 5) for the emission of air which may have entered the syphon tube from the boiler. When the plug is in the position shown (Figs. 2 and 5) the whole of the water in the gauge glass and the vessel behind it, can escape through the passage 6 in the plug 5, and the passages *b*, *s*, and 10, and the gauge fills with air at the temperature of the boiler-room. At the same time there is a leakage from the syphon past the valve V, and all the air escapes from that part of the apparatus. When the handle H is turned until the finger P comes against the stop "open" (Fig. 6), the water is free to flow back into the gauge, and to compress the measured quantity of air above it.

The construction of the gauge is clearly shown in the engravings. Fig. 1 is a front elevation showing the scale immediately behind the tube. Fig. 2 is a vertical section; the gauge glass, it will be seen, can be renewed without trouble, by withdrawing the plug S, the joint being made by the washers 3. Fig. 3 is a part plan, showing the handle H and the stops between which it works. Fig. 4 is a plan showing the top of the instrument. Fig. 5 is a section of the plug, and Fig. 6 an external view.

It will be unnecessary to point out to our readers the advantage of a gauge spring which cannot be strained, deformed, or corroded, and which needs no multiplying gear to render its movements visible. The inaccuracies of the ordinary gauge of commerce are well known, that the instruments of most makers have but little value until they have been tested and their errors determined. The powers of the springs vary very greatly with the temperature, and also suffer a change from use, so that even if correct when new they need to be regularly tested from time to time. But with the gauge before us, the elasticity is perfect, and if any doubt be felt, the air can be renewed at any moment. The only cause of variation which can affect it is change of temperature. A rise or fall of 10 deg. will alter the reading by 2 per cent.—a trifle compared with the effect the same change will make on some gauges—but if extreme accuracy be needed it is easy to glance at the thermometer and make an allowance, or better still, to renew the air. It is a very slight matter on board a steamer to turn the cock at the bottom of the gauge when the vessel enters warmer latitudes, and to repeat the process when she returns to a more northern climate. Mr. Alexander Allan's address is, The Valley, Scarborough.

ENGINES OF THE S.S. "WARRINGTON."

WE give this week a two-page engraving of the triple-expansion engines of the s.s. Warrington, these engines having been constructed by Messrs. Westgarth, English, and Co., of Middlesbrough-on-Tees. The Warrington is one of the new vessels built last summer for the Manchester, Sheffield, and Lincolnshire Railway Company, by Messrs. C. S. Swan and Hunter, of Wallsend-upon-Tyne, and is engaged on the Grimsby and Continental passenger service. She is 230 ft. long between perpendiculars, 30 ft. beam, and 16 ft. 11 in. deep, and on her trial trip when loaded to a mean draught of 16 ft. she attained a mean speed of 12.64 knots, giving constants 745 and 279.

The engines of the Warrington, of which our two-page engraving gives two perspective views, have cylinders respectively 22 in., 35 in., and 57 in. in diameter, the stroke in all cases being 4 ft. 6 in. The cylinders are not steam jacketted, but the high-pressure cylinder is fitted with a liner. The high-pressure cylinder is fitted with a piston valve and the other cylinders with ordinary slide valves, that of the intermediate cylinder being of the Trick pattern and that of the low-pressure cylinder double ported. The valve gear is the ordinary link motion, and the reversing gear is of the "all round" type, an arm on the reversing shaft being connected by a link to a crank-pin in the face of a wormwheel driven by the reversing engine. This latter engine is so arranged that by means of a belt it can be used to drive the turning gear. The engines can also be reversed by hand, and provision is made for independently adjusting the cut-off in each cylinder.

The general design of the framing is shown so clearly by our engravings, that no description will be necessary. The arrangement gives an open and accessible engine. The crankshaft is 11½ in. in diameter, and has six bearings. The air pump is single-acting and 20 in. in diameter, while the circulating pump is double-acting and 11 in. in diameter; the stroke of both pumps is 22 in., and they are worked through the usual rocking levers from the crosshead of the intermediate cylinder. The condenser has 1700 square feet of cooling surface.

The engines are supplied with steam by two single-

ended boilers, each 12 ft. 6 in. in mean diameter and 10 ft. 10½ in. long, and each having two corrugated furnaces 48 in. in diameter. The total heating surface exposed by the two boilers is 3000 square feet, and the total firegrate area 92 square feet. The working pressure is 150 lb. per square inch, and the engines have indicated 1100 horse-power.

The Warrington has proved a very successful vessel, and has made the quickest recorded passages from Grimsby to Hamburg, and also to Antwerp and Rotterdam, the time from port to port in each case being 28 hours 10 min., 18 hours 25 min., and 14 hours 50 min., respectively. On many of her passages she has averaged over 13 knots, and in one case 14 knots per hour.

THE SCOTCH STEEL TRADE IN 1886.

THIS branch of industry continues to become more and more important from year to year. As is well known, it is of very recent origin, and yet the manufacture of mild steel, by the Siemens process, is pursued more extensively in Lanarkshire than in any other part of the kingdom, one reason being that the material produced upholds its very high reputation for quality amongst consumers. There are no fewer than six large works in that county devoted to the industry, namely, Newton and Blochairn Works, belonging to the Steel Company of Scotland; Parkhead Works, belonging to Messrs. Beardmore; and the Dalzell, Clydesdale, and Mossend Works, all in the Motherwell district. By far the largest works are those first mentioned. There are at least two other smaller works at which the same process is pursued, belonging, respectively, to the Coats Iron and Steel Company, and Mr. John Spencer, and both situated in the Coatbridge district. At Glengarnock, in Ayrshire, and at Wishaw, in Lanarkshire, there are now works in operation for pursuing the basic-Bessemer process on an extensive scale.

Notwithstanding the general depression in almost all the great industries of the country during the past year, the production of steel in Scotland reached a larger total than in any preceding year, the prime reason being, that steel as a material of construction is getting into more and more extensive request, alike for shipbuilding, boilermaking, bridgebuilding, engine shafting, &c. Prices, however, suffered very considerably during the year 1886. For example, steel for shipbuilding purposes, including two-thirds plates and one-third angle bars, was quoted in January at 6*l.* 5s. per ton, whereas in September the quotation had fallen to 5*l.* 5s. per ton. Boiler plates were quoted at proportional rates.

Very considerable quantities of shipbuilding steel were booked at unprecedentedly low prices during the months of August and September, both speculatively and for legitimate purposes. Sales of boiler plates, for instance, were reported to have been made at prices ranging down so low as 6*l.* per ton overhead, while angle bars brought as low as 5*l.* per ton, and all less 5 per cent. delivered. It is scarcely probable that Siemens steel of high quality could be made remuneratively at such rates. In the course of the past month shipbuilding steel advanced in price to 5*l.* 15s. per ton, so that it may now be regarded as tolerably certain that an upward scale of prices will have to be paid by consumers; indeed, that is rendered almost necessary in view of the higher prices now demanded for pig iron and coal than those that were current a year ago. It ought to be mentioned that when the prices became so low last autumn, two of the large works almost entirely ceased to make any steel for shipbuilding purposes, their owners preferring rather to cease booking orders until the prices should become more remunerative. One of the Coatbridge works followed the same example.

Much attention has of late been given to the question of working Siemens steel furnaces by water-oil gas, in accordance with the provisions of an American patent. Experiments upon a considerable scale have been conducted privately at Blochairn Works, and the process of generating and using this form of gaseous fuel has been attended with such a large measure of success as to lead to the confident hope that we are on the eve of a much cheaper method of making mild steel. It is stated that contracts have been entered into for the adoption of the process at three of the works in the Glasgow district.

The labour question caused some disorganisation at the Dalzell Steel Works, over a period of several weeks during the past year, owing to an endeavour on the part of Messrs. Colville and Sons to reduce the workmen's wages. Workmen were brought from Wales to take charge in two or three departments, but they were found to be unqualified hands, and they had to be got quit of. The workmen who went on strike or were locked out remained firm, the consequence being that work was forthwith resumed by the old hands at the former rates of wages or thereabouts. Since then affairs have proceeded harmoniously between the masters and the men. There was also a little hitch between the Steel Company of Scotland and their workmen, the latter putting in a claim for higher rates of remuneration; but the hitch came to nothing, except that it was clearly shown to the men's representatives that no advance in the rate of wages was possible with the low prices then obtainable for the finished products.

Up to the present, the basic steel made in Scotland has not got into use for shipbuilding purposes. Large quantities of it are sent to America in the form of blooms, and no mean proportion of the make at Glengarnock finds its way in the shape of billets to the South Wales tin-plate works. At the Wishaw Works a considerable amount of the basic steel made has been rolled and transformed into railway sleepers, and some of the plates or sheets have been used for constructing railway wagons. In conclusion, it may be mentioned that the price of basic steel, in sympathy with that of Siemens steel, has been advanced in price 5s. per ton.

ELECTRICAL WELDING.

PROFESSOR ELIHU THOMSON, of the Thomson-Houston Electric Light Company, has recently read a paper at the Massachusetts Institute of Technology, "On the Art of Electric Welding," and as this subject is attracting considerable attention on this side of the Atlantic also, we lay before our readers a summary of his remarks. In the Thomson-Houston factory all the copper and iron wire used is welded by aid of electricity. The largest copper rod yet joined by this method is a little less than ½ in. in diameter, and requires a current of 20,000 ampères. The same current will weld an iron rod 1 in. in diameter, as this metal offers greater resistance. Specimens of welded wires were shown to the audience, as well as of iron, brass, and copper tubes. Also drills, bolts, and screws, which had been cut and lengthened by the insertion of extra pieces between the head and the point.

The enormous currents used in welding have only a small electromotive force, sometimes as little as half a volt, so that the actual energy employed is not excessive and is only in operation for one or two minutes. One method of obtaining it is by the use of a secondary battery. This is charged from an electric lighting circuit with the cells in series; when required for use the order of cells is changed so that they are parallel and offer an exceedingly small resistance to the current. Very rapid discharge has, however, a prejudicial action on secondary batteries, and consequently a transformer of the induction coil type is a more convenient apparatus to use. The principle of these apparatus is well understood, and has already been turned to account in the secondary generators of the Gaulard and Gibbs system. An alternating current from a dynamo machine is made to circulate in a coil of insulated wire surrounding a wrought-iron bar or core. This is called the primary coil. On the same bar is wound another or secondary coil, either above or below or alongside the primary. At every alternation of current in the primary coil, there is induced a temporary current in the secondary coil, and the energy in the induced current is equal (less the loss in the apparatus) to the energy lost by the primary current. But by a proper proportioning of the two wires the character of the secondary current may be greatly modified, and its electromotive force be made either greater or less than that of the current which induces it. In electric lighting it is customary to work with a primary current of 2000 volts, and to reduce it to between 50 and 100 volts with a corresponding increase in the number of ampères, but for welding only one or two volts are required. Fig. 1

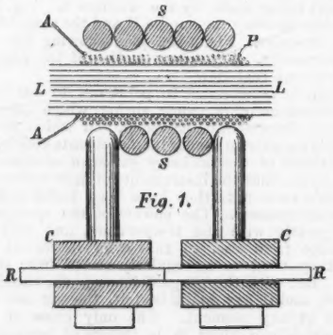


Fig. 1.

shows the construction of transformer which has been employed at the Thomson-Houston works. The core L is formed of a bundle of fine iron wires, and around it is wound the primary coil P, the terminals of which, A A, are connected to an alternating current generator, giving 50 to 100 alternations per second. The length of the wire core is 12 in. and its diameter 1½ in. The secondary coil S S is composed of 64 No. 10 (Brown and Sharpe's gauge) copper wires, wound in parallel eight times around the primary. The ends of this coil are bolted to copper plates on which are mounted clamps C C for the reception of the two rods R R which are to be welded. One of these clamps is movable and is constantly pressed towards the other by a spring, so that the pieces to be united are kept in firm contact. The resistance of the secondary coil is .00015 ohms, and the amount of energy given off by it can be varied by moving the core L L in and out of the primary coil.

Fig. 2 illustrates another construction of transformer.

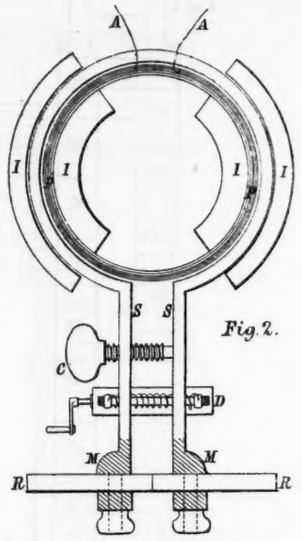


Fig. 2.

The primary coil P is a ring 12 in. in diameter, 2½ in. wide and ⅝ in. thick, of many turns of insulated copper wire. Its ends A A are connected to the terminals of the alternating dynamo. The secondary coil is a single heavy bar of copper, bent to make one turn outside the primary coil, and is represented by the heavy black ring, the terminals of which, S S, are bent out parallel, and connected to massive clamps M M. The arms T T can be forced apart by the screw C, and drawn together by the adjustable spring D. The primary and secondary coils are wound with an endless coil of iron wire I I. This does not touch the coils, but is laid on a sheet-iron casing, the secondary coil being free. The resistance of the secondary coil is .00003 ohms, and under the influence of a good primary current it gives an electromotive force of 2 volts; less, however, is used in most cases. In the primary circuit there is used a current of 20 ampères and 600 volts, generated in a dynamo weighing 500 lb., and absorbing 25 horse-power at 1800 revolutions.

During the lecture mild steel rods, ½ in. in diameter, were placed end to end in the clamps of the machine (Fig. 2), and were welded before the audience. Copper and brass rods were similarly treated, and tests were afterwards made to demonstrate that the joints were perfectly sound.

NEW RUSSIAN CRUISERS.—The Russian Government is reported to have decided upon constructing six more vessels of the type of the Vitiaz and Rinda, cruiser corvettes of the first category recently added to the Baltic fleet. These vessels are 265 ft. in length, 45 ft. in breadth, and 14 ft. and 18 ft. respectively fore and aft. They are fitted with compound engines 3600 horse-power indicated, and steam 16½ knots per hour. At the lower rate of 14 knots per hour they can steam 3500 miles without stopping to coal; at 13 knots, nearly 5000 miles; at 12 knots, 5750 miles; and at 8 knots or 10 knots, upwards of 10,000 miles. The armament consists of ten 6-in. rifled guns, eight Hotchkiss guns, and four 4-pounders, while besides being equipped for discharging Whitehead torpedoes, the cruisers carry a couple of torpedo cutters 32 ft. long, armed with Baranovsky guns.

AGRICULTURAL IMPLEMENTS AND MACHINES IN INDIA.—A return has been issued from the Government press at Simla of implements and machines which have met with marked success in India during the years 1882-3 to 1885-6, and also of machines which have been tested in India during the year 1885-6, and have been found efficient and useful. From the former report we find that the introduction of new implements proceeds very slowly. Among the ploughs the Swedish appears to have met with the most success. The Cawnpore chain pump obtains approval, but it is too expensive for the natives to buy. The same is true of various types of English winnowing machines. Sugar mills, particularly the Behea, are the only modern machines which appear to be received eagerly by the people. In the latter return we find Jessop's Hindustani plough and Ransome's English plough well spoken of, as is also the single-horse thrasher of Messrs. Gray and Sons, of America. Messrs. Milne and Thomson's centrifugal sugar-making and other machines are selling well.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1883.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

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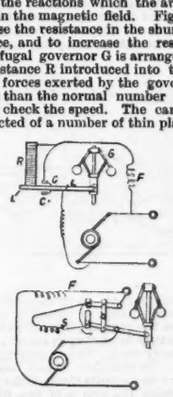
Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

DYNAMO-ELECTRIC MACHINES.

10,646. H. H. Lake, London. (*S. F. Van-Choate, New York, U.S.A.*) **Armatures for Electric Generators.** [8*d.* 16 *Figs.*] September 18, 1885.—This invention has for its object to prevent the formation of neutralising or "Foucault" currents nthe frame or body of the armature. The improved armature consists of a flat ring of magnetic material with a coil of iron wire on each side. This flat ring is provided with internal projections or teeth fitting into notches in the hub or central portion of the armature. The armature coils on either side of the frame are separated by V-shaped blocks of wood or other non-magnetic material which form a continuous flush surface with the radial coils of copper wire. (*Sealed October* 8, 1886).

12,084. J. Hopkinson, London, and E. Hopkinson, Manchester. Improvements in Dynamo-Electric Machines. [8*d.* 4 *Figs.*] October 10, 1885.—Inventors claim a multipolar dynamo machine in which the number of electromagnets is less than the number of magnetic fields. (*Sealed December* 14, 1886).

12,982. W. M. Mordey and C. Watson, London. Improvements in Constant-Speed Electric Motors. [8*d.* 12 *Figs.*] October 28, 1885.—The motors constructed according to this invention are designed to be worked by connecting them to mains supplying electric energy in which a constant difference of potential is maintained between the connections of the motor with the mains. The motors are shunt wound. A fundamental condition in carrying out this invention is that the field magnets must be so much more powerful than the armature, so as to overpower the reactions which the armature would otherwise bring about in the magnetic field. Fig. 1 shows a device arranged to decrease the resistance in the shunt circuit when a rise of speed takes place, and to increase the resistance on a fall of speed. The centrifugal governor G is arranged to operate upon a carbon contact resistance R introduced into the shunt circuit F; any of the varying forces exerted by the governor will, at higher or lower potentials than the normal number of volts, come into operation to aid or check the speed. The carbon resistance R is preferably constructed of a number of thin plates the resistance of



which is varied by pressure as required. The lever L pivotted at L^1 rests on the lower contact-piece C^1 when the motor is at rest, but is lifted from that position by the governor G, the carbons being thus thrown into the shunt circuit. The pressure is gradually increased as the speed rises, and when the full compression is reached, the lever L short-circuits the resistance R by making contact with the upper contact-piece C. The contact-pieces C, C^1, are preferably borne on springs, and are adjustable. Fig. 2 shows an automatic centrifugally controlled switch for either short-circuiting or reversing the series winding. F is the shunt winding, and S is the series winding. The reversal of rotation is obtained by simply reversing the direction of the current through the armature or through the field magnet circuit. The position of the brushes is practically the same for either direction of rotation, no movement of them is necessary, and only one set of brushes is required. The brushes consist of a number of plates or ribbons placed side by side, and making contact with the commutator at the edges, which are preferably placed at right angles to the axis of the commutator. (*Sealed November* 19, 1886).

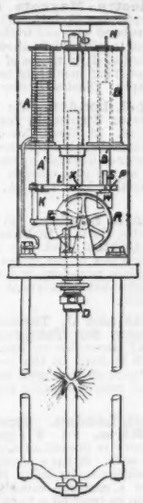
13,744. E. J. Houghton, London. Apparatus for Intercepting the Current from Dynamo-Electric Machines. [8*d.* 1 *Fig.*] November 11, 1885.—A screw blade contained in a vessel filled with mercury is driven by a strap from the armature spindle so as to cause the mercury to rise in a tube of insulating material up to a contact-piece, and thus close an electric circuit whereby the armature of an electro-magnet is attracted and a resistance introduced into the main or shunt circuit of the dynamo. (*Sealed December* 3, 1886).

8786. S. H. Tacy, New York, U.S.A. Improvements in Dynamo-Electrical Machines or Motors. [6*d.* 1 *Fig.*] July 5, 1886.—The object of this invention is to render dynamo-electrical machines incapable of igniting combustible gases in mines. This is effected by enveloping the commutator and brushes, where sparking takes place, in a flame intercepting envelope of wire gauze or glass or mica. (*Sealed November* 5, 1886).

ELECTRIC LIGHTING.

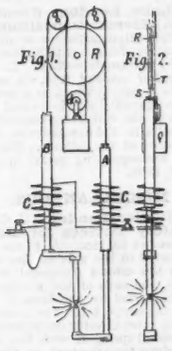
12,110. R. H. Ridout, London. Telephones. [8*d.* 6 *Figs.*] October 12, 1885.—Inventor claims chiefly a telephone transmitter operating with friction without change of pressure upon contacts included in an electric circuit; also the method of supporting the diaphragm of a telephone receiver at intervals along its edge, and not continuously between flanges according to the usual practice. (*Sealed October* 19, 1886).

12,681. J. Brockie and B. Pell, London. Arc Lamps. [8*d.* 5 *Figs.*] October 22, 1885.—The regulation of the arc is effected by the movement of the upper carbon-holder D. A rocking lever L pivotted at X, operates by means of a link K the clutching device C on the periphery of the wheel R which is driven by the weight of the upper carbon-holder D. To one end of lever L is jointed the core A^1 of the solenoid A, the coil of which forms part of the main lamp circuit; its duty being primarily to separate the carbons when the current is established and thus to start the arc. The core B^1 of the other solenoid B, which is wound in a shunt circuit or by-pass to the arc, has a slotted connection S to the other end of the lever L, so that the lever may be moved up and down by the main core A^1 to the extent of the slot without



any corresponding movement of the shunt core B^1. But when the pin P is at the lower end of the slot S, the shunt core B^1 on being attracted upwards will raise one end of the lever L, depressing the other in opposition to the pull of the core of the main coil A, and thus permitting the carbons to approach each other. The shunt coil core B^1 is suspended by a link N, so that it is quite independent of the lever L. The shunt coil may thus be of very much greater power than the main coil, and the regulating weight W is applied directly to the shunt coil itself and not to the lever L, so that any desired portion of main current influence may be introduced into the regulation of the lamp. (*Sealed November* 16, 1886).

13,810. V. Klan and F. Spurny, Prague, Bohemia. Electric Lamps. [8*d.* 4 *Figs.*] November 12, 1885.—The carbon-holders A and B are passed through solenoids C, C, and are suspended from two independent cords S, T, secured to both holders; the cord S being passed over the fixed pulley R, whilst the cord T passes over the fixed pulleys *a*, *b*, and the movable pulley *d*. As soon as any acceleration is caused by the difference of magnetic attraction of the two solenoids, this acceleration is



communicated to the mass of the movable pulley *d* and the weight Q, so as to move the centre of the pulley in the opposite direction to that caused by the acceleration of the holder. The cord T slackens or pulls the other holder more than the cord S of the other pulley system, and thus the acceleration is always counterbalanced, and the carbons are moved with constant speed and without fluctuation. (*Sealed November* 23, 1886).

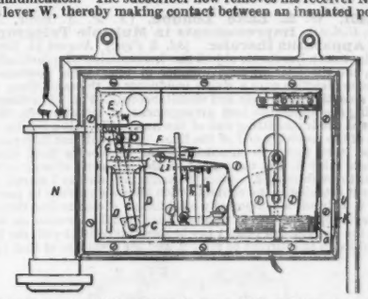
1726. L. S. Powell and R. P. Sellon, London. Manufacture of Incandescent Electric Lamps. [8*d.* 3 *Figs.*] February 5, 1886.—According to this invention the carbon filament is lowered gradually into mercury while raised to incandescence under a constant electrical pressure, until the incandescence of its non-impressed portion coincides with a visual standard, for the purpose of insuring a practical uniformity of incandescence in lamps. (*Sealed November* 9, 1886).

3149. A. Bernstein, London. Incandescent Electric Lamps. [8*d.* 2 *Figs.*] March 5, 1886.—According to this invention the ends of the carbon or light-giving body in lamps of low resistance are connected with the leading-in wires by means of conductors which are flexible in the direction of the carbon so as to prevent the carbon from being strained through the expansion or contraction of the several parts of the lamp. (*Sealed November* 5, 1886).

TELEGRAPHY AND TELEPHONY.

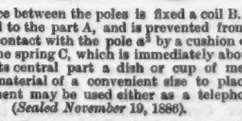
12,661. J. Swinburne, Brockley, Kent. Filaments for Electric Glow Lamps. [8*d.* 3 *Figs.*] October 8, 1885.—According to this invention a long thin filament for incandescent lamps of high electromotive force is supported at intermediate points along its length, and may consist of two or more loops. (*Sealed December* 14, 1886).

13,696. J. Stephen, Blackhall, Midlothian, N.B. Improvements in Telephonic Systems. [8*d.* 9 *Figs.*] November 10, 1885.—The object of this invention is to provide means for arranging a number of telephones so that they may all be served by one line. The illustration represents the improvements as applied to a subscriber's telephone; N is a Bell receiver; the transmitter is not shown. C is an electro-magnet mounted in a frame C^1 capable of movement between the poles of two horseshoe permanent magnets D, the front one only being shown. When a subscriber wishes to communicate with another subscriber, he calls up the exchange attendant by depressing the Morse key or contact-maker K, thereby breaking contact with the piece U and making contact at *a* with one pole of a local battery. A current from this battery then passes through the fulcrum of the key K to the frame C^1 and the electro-magnet C and thence to the bell at the exchange, whence the attendant sends a current to release the contact-maker H, so that the current traverses the relay I and rings the subscriber's bell. The subscriber then rings back, whereupon the exchange attendant sends a reverse current through the line which locks out all the subscribers except those who desire to be put into communication. The subscriber now removes his receiver N from the lever W, thereby making contact between an insulated portion



c of the lever, to which portion is connected one terminal of the transmitter battery, and one terminal of a primary coil in series with the transmitter and the other pole of the transmitter battery. At the same time the other portion of the lever W makes contact with one terminal *cf* the secondary coil, which is in series with the receiver N and with the exit terminal of the line. The conversation may now go on without fear of interruption or overhearing. When the attendant is apprised that the conversation is over, he depresses the key that sends a positive current along the line, when all the electro-magnets will again pass to the right. The frame C^1 is provided at its upper end with a disc E for indicating when the line is inaccessible and when it is free. L^2 is an arm attached to the pendulum L for raising the hooked levers F for releasing the contact-maker H, which, when released, falls over and makes contact with the piece A of the relay I. The striker L^2 only acts when the exchange attendant has set his metronome opposite the number of the subscriber. (*Sealed November* 16, 1886).

13,828. S. P. Thompson, London, and P. Jolin, Bristol. Magneto-Telephonic Instruments. [8*d.* 2 *Figs.*] November 12, 1885.—A long narrow triangular strip of steel A (Fig. 1) having a circular slot cut out of its broad end at *a*, is bent so that the narrow end a^2 passes up into the slot. The curved strip is then magnetised, so that the end a^2 constitutes one pole, and the edges of the slot *a* the other pole of the magnet. In the



annular space between the poles is fixed a coil B. A steel spring C is fastened to the part A, and is prevented from being brought into actual contact with the pole a^2 by a cushion of cork. To that portion of the spring C, which is immediately above the pole a^2, is rivetted at its central part a dish or cup of metal, ebonite, or other hard material of a convenient size to place over the ear. This instrument may be used either as a telephonic receiver or transmitter. (*Sealed November* 19, 1886).

14,917. S. Z. de Ferranti and G. L. Addenbrooke, London. Improvements in Telephony and Telegraphy. [8*d.* 4 *Figs.*] December 4, 1885.—The improvements consist in the use of an induction apparatus, of which the primary forms part of a local circuit, including a battery and a telephone transmitter, whilst the secondary forms part of a line circuit; these primary and secondary coils being wound upon an iron core which is either formed into a complete ring or rings, or which has its ends approximated so that the magnetic circuit in the core is completed through metal, or more nearly so than when a straight core is employed. (*Accepted October* 22, 1886).

5093. G. W. Baldridge, St. Louis, Missouri, U.S.A. Improvements in Telegraph Transmitters. [8*d.* 9 *Figs.*] April 12, 1886.—To the standard B is fixed a bracket in

Fig. 1.

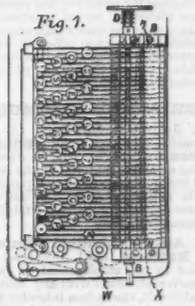
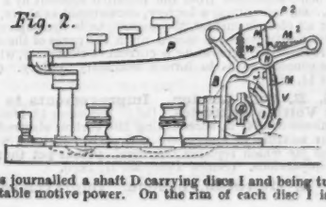


Fig. 2.

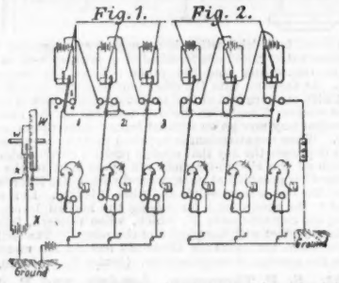


which is journalled a shaft D carrying discs I and being turned by any suitable motive power. On the rim of each disc I is a tele-

graphic character formed by alternating non-conducting spaces. The electricity passes through the wire W (Fig. 1) to the shaft D and discs I, and then to the brushes V, arms M, rod N, and out along the line wire X. The shaft D is first set in motion to turn the discs in the direction indicated by the arrow. As soon as the key P is struck, its short end will be raised, releasing the arm M and permitting the non-conducting pin L to be brought against its disc by the spring M^2. And as soon as the groove J comes to the pin, the latter enters the groove, allowing the brush V to come against the periphery of the disc and close the circuit, sending the character on the disc. As the pin approaches the end of the groove it meets a catch which forces both the pin and the brush out of contact with the disc, and in doing so forces the extension M^1 of the arm M inward past the notch P^2 of the key P, which is then pulled down by the spring *w*, so as to hold the arm M in the position shown until the key is again operated. (*Sealed October* 12, 1886).

10,451. W. R. Lake, London. (*A. M. A. Beale, New York, U.S.A.*) **Improvements in Multiple Telegraphy and Apparatus therefor.** [8*d.* 3 *Figs.*] August 14, 1886.—This invention has for its object the transmission of practically a large, and theoretically any, number of telegraphic messages in the same direction over a single conductor at the same time, and their reception separately and simultaneously. Fig. 1 is a diagram showing the apparatus and arrangement of circuits with three relays at the transmitting end of the line. Fig. 2 is a similar diagram of the receiving end of the line. A current sent into relay 1 causes it to move its armature so as to close a local circuit through relay 2, the movement of the armature closing a local circuit through relay 3. After the armature of relay 1 starts, and before it establishes the contact which allows a current to pass to relay 2, a circuit is temporarily established direct to line through the key of operator No. 1, who can then signal. As soon as, however, the armature of relay 1 has broken this contact with the line, establishes the current to relay 2, and the armature of that relay

Fig. 1. *Fig. 2.*



moves in like manner, so as to establish a line connection for operator No. 2. A line connection is made in the same way for operator No. 3 by starting relay 3. But to the senses these three relay armatures appear to move simultaneously; and thus the line connections seem to be simultaneous, and the operators may write sensibly at the same time, although really their signals go to line at successive but very rapidly recurring intervals, and therefore do not interfere with one another. W is a wheel of insulating material having on its periphery equally spaced contact plates which communicate with the contact plates of a commutator *w*. The brushes *x* of the commutator communicate with the poles of a split battery X. The wheel W being caused to rotate uniformly, the current from the battery X passes to the contact plates on the wheel W alternately in opposite directions, so that the brush or spring *z* conducts away, as it meets each contact plate in turn, alternate positive and negative currents. 1, 2, 3 are polarised relays, of which *a*, *a* are the magnets, and *b* the armature. (*Sealed November* 19, 1886).

11,499. H. H. Lake, London. (*D. Drawbaugh, Eberly's Mills, Penn., U.S.A.*) **Telephonic Apparatus, Chiefly Designed for Transmitting Sound Vibrations Existing in or Communicated through the Earth.** [6*d.* 3 *Figs.*] September 9, 1886.—This invention consists of the combination of a microphone with an apparatus adapted for insertion into the earth. This instrument is especially suitable for military purposes by revealing the approach of an enemy. (*Accepted October* 26, 1886).

11,977. W. Stanley, Great Barrington, Mass., U.S.A. Induction Coils. [6*d.* 2 *Figs.*] September 21, 1886.—The primary and secondary conductors of the induction coil are wound to form an annulus which extends through a series of magnetically separated slotted plates of soft iron. (*Accepted October* 26, 1886).

11,978. W. Stanley, Great Barrington, Mass., U.S.A. Induction Coils. [8*d.* 4 *Figs.*] September 21, 1886.—The core of the coil is formed of thin plates of magnetic material, each provided with slots for receiving the primary and secondary conductors. These plates are bolted together side by side with the openings for receiving the wire in alignment with each other, but they are separated from each other by washers or plates of non-magnetic material. The coils are wound in the openings formed in the plates, and are thus bounded upon both sides by soft iron. (*Accepted October* 29, 1886).

BATTERIES AND ACCUMULATORS.

13,697. J. Y. Johnson, London. (*S. Farbaky and Dr. S. Schenek, Schemnitz, Hungary.*) **Secondary Batteries or Electrical Accumulators.** [8*d.* 2 *Figs.*] November 10, 1885.—The packing or active material of the negative plates consists of powdered litharge and granulated pumice stone intimately mixed with dilute sulphuric acid. The active material of the positive pole plates consists of litharge, minium, and powdered coke. (*Sealed December* 3, 1886).

14,986. G. J. Atkins, London. Improved Electric and Storage Battery. [6*d.*] December 7, 1885.—The improvements consist in the employment of carbon for both the positive and negative elements with any suitable dilute acid or solution of a metallic salt, the carbon intended to form the positive element being separated from the negative element by a porous partition. On submitting a battery, constructed as above, to the action of an electric current, the electrolyte is decomposed, and some of its constituents are stored up in the pores of the carbon, and are redissolved, generating a current of electricity, when the poles are coupled so as to form a secondary battery. (*Sealed December* 14, 1886).

15,285. B. Poll, London. Improvements in Manganese Voltaic Batteries. [4*d.*] December 12, 1885.—The improvements consist in surrounding the carbon electrode with a granular mixture of manganese and carbon inclosed within a perforated jar which replaces the usual porous pot that often becomes impervious. (*Sealed December* 17, 1886).

8376. A. Muirhead, London. Improvements in Clark Standards of Electromotive Force and other Galvanic Cells having Mercury Electrodes. [6*d.* 5 *Figs.*] June 25, 1886.—The improvements consist in confining the mercury in a chamber of gauze, perforated sheet, or wire of platinum or platinum-iridium, with the object of making the cell more portable and of insuring a better contact between the mercury and the platinum in all positions of the cell. (*Sealed October* 5, 1886).

CONDUCTORS, INSULATORS, &c.

11,570. P. M. Justice, London. (*H. C. Spalding, Boston, Mass., U.S.A.*) **Electro-Magnets and Conductors.** [1*s.* 1*d.* 21 *Figs.*] September 29, 1885.—This invention relates to the preparation of insulated wire and to the apparatus employed in manufacturing it and to wind it into electro-magnets or like devices. The wire is insulated by means of a coating of a permanently viscous or non-drying insulating material and a spirally wound wrapping of paper. (*Sealed October* 19, 1886).

14,337. C. D. Abel, London. (*La Compagnie de Fives-Lille, Paris.*) **Posts or Supports for Electrical Conducting Wires.** [8*d.* 12 *Figs.*] November 23, 1885.—Four angle-irons forming a tapering structure for the lower part of the post are secured together at intervals by means of distance-pieces, whilst the upper part of the post consists of two or four angle-irons fixed closely together back to back. (*Sealed December* 3, 1886).

14,633. A. M. Clark, London. (*E. Flotron, Nice, and F. B. A. Royer de la Bastie, Paris.*) **Submarine and Subterranean Electric Cables.** [8*d.* 14 *Figs.*] November 28, 1885.—The conducting wires of the cables are inclosed in short lengths of toughened glass, porcelain, or earthenware made in the form of fluted or perforated cylinders of a star-shaped section. (*Sealed December* 7, 1886).

15,794. A. Eadie and J. Tannahill, Rutherglen, Lanark, N.B. Posts for Telegraph or Telephone Lines. [8*d.* 9 *Figs.*] December 23, 1885.—The pile or bottom part of the post, which is fixed in the ground, is made with a tapered socket and flange at its upper end into which fits the bottom end of a tapered tube of wrought iron or steel. (*Accepted October* 22, 1886).

409. W. Reddall, London. Street Curb for Receiving Electric Wires. [8*d.* 8 *Figs.*] January 9, 1886.—The improved street curb is formed as a channel-shaped box of cast iron open at both ends. It has a circular perforated bottom for drainage, and a drainage cavity below the perforated bottom. The curb is covered by a cast-iron cover with a roughened top. This cover is grooved on its front edge to fit the front of the curb, and at its back edge fits into a bevelled groove formed in the back of the curb. (*Accepted October* 22, 1886).

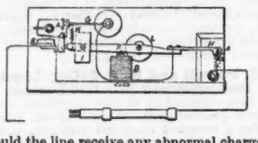
WORKING METALS.

12,984. N. de Benardos and S. Olszewski, St. Petersburg. Method of, and Apparatus for, the Working of Metals and Metalloids by the Direct Application of Electric Currents. [1*s.* 3*d.* 38 *Figs.*] October 28, 1885.—A voltaic arc is formed by the approach of a carbon to the part of the metal to be operated on. The carbon forms one pole and the metal forms the other pole of the circuit. The carbon is preferably a hollow pencil or rod, and may be filled with various metals or alloys which play the part of solder. The voltaic arc thus produced, is employed to weld and solder metals either at separate points or in a continuous joint; to drill or form holes in metals by means of the incandescent carbon; and to apply metallic coatings to metals and metalloids by fusing the same. Jets of gas with or without admixture of pulverulent material may be introduced into the voltaic arc for the purpose of modifying its action. (*Sealed December* 14, 1886).

10,607. W. R. Lake, London. (*Count R. de Montgelas, Philadelphia, U.S.A.*) **Electro-Deposition of Aluminium.** [4*d.*] August 18, 1886.—Hydrochlorate of aluminium in a fluid form obtained by treating alumina with hydrochloric acid, is first freed from its iron by electro-deposition. To the residual liquid is added half its weight of oxide of lead, tin, or zinc, and the mixture is then placed in a cell in which is a porous vessel containing an element of amalgamated zinc immersed in dilute sulphuric acid. The terminals of the cell being connected, the decomposition of the liquid results in the deposition of aluminium with the metal of the added oxide at the cathode. The aluminium is then separated from its accompanying metal in any suitable way. (*Sealed November* 30, 1886).

MISCELLANEOUS.

11,574. P. M. Justice, London. (*H. C. Spalding, Boston, Mass., U.S.A.*) **Safety Devices for Electric Circuits.** [8*d.* 5 *Figs.*] September 29, 1885.—A, E, are metal plates with corrugated edges secured to the side of the support. Normally the current follows the circuit composed of the plate A, the fusible safety strip G, the coils of the electro-magnet B, and the metal arm H which is carried by the lever F of non-conducting material pivotted to the support L. The current passes from the arm H out by a spring catch C to the underground line. The lever F is connected by a spiral spring K with the safety strip G which has the tendency to draw the armature on the lever F away from the poles of the magnet B. I is a sliding weight placed on the



lever F. Should the line receive any abnormal charge, the instruments and the line may be saved from damage by the current leaping across from the plate A to the plate E, and going direct to earth. If this does not take place, the strip G will either be fused, or the magnet B energised sufficiently to draw down the armature on the lever E. In either case, the movement of the armature lever F brings the link D into contact with the plate E, thus establishing a shunt to earth, and releases the spring catch C, whereby the catch *d* is raised, comes into contact with a pin, locking the lever F in its raised position, and keeping the shunt circuit closed and the main circuit open until the catch *d* is released by hand. (*Sealed October* 12, 1886).

13,873. A. Grundy, London. Apparatus for Regulating and Controlling Electric Currents. [8*d.* 4 *Figs.*] November 13, 1885.—The object of this invention is to provide an instrument which, being inserted in the circuit of an electric generator when being used for charging an accumulator or secondary battery, shall insure that the charging current is in the right direction; that the current is of a sufficiently high potential to insure safe charging; and that, in the event of injurious variations of the potential of the generator and of the accumulator, the instrument shall certainly and automatically disconnect the generator from the accumulator, and at the same time insert a resistance in each circuit. The upper end of the electro-magnet *p* has a slit in which is pivotted an armature s^1 of steel free to move in a horizontal direction between the poles of the horseshoe magnet which is composed of the two cores C, C^1, and the connecting-piece. *d* and *e* are cups filled with mercury for making contact with metal plungers attached to arms *t*, t^1 (Fig. 2) fixed to an insulating spindle; contact at *d* is broken when the arm

Fig. 1.

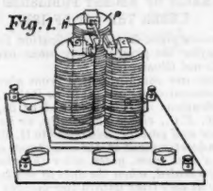
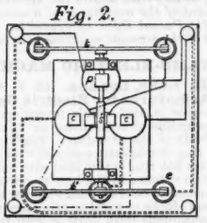
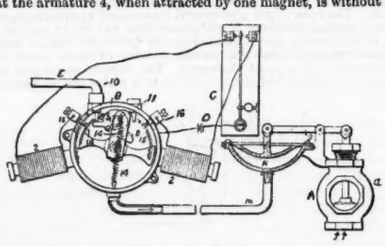


Fig. 2.



t is fully depressed towards *i*. The horseshoe electro-magnet C, C^1, in the main circuit is wound with two helices of thick wire in opposite directions, one winding being connected between the terminals of the accumulator, and the other between the terminals of the generator. (*Sealed November* 30, 1886).

6669. W. S. Johnson, Milwaukee, Wisconsin, U.S.A. Electric Valves. [8*d.* 2 *Figs.*] May 18, 1886.—This invention relates to an apparatus designed to control valves by means of a current of electricity. The spindle of the valve A to be controlled is operated through a lever *g* by means of a flexible diaphragm forming the upper surface of an air-tight chamber K to which fluid under pressure is admitted by means of the electrically operated valve B. C is the thermostat which makes at a remote point the electric circuit that operates the valve B. The orifices of the admission nozzle 10 of the supply pipe E for the compressed fluid and of the exhaust nozzle 11 of the casing of the valve B are controlled by arms 8 of a disc 5 which, by means of an arm 12 eccentrically fixed on the disc, is operated by the oscillation of the pivotted armature 4. Electro-magnets 2, 2 are so arranged that the armature 4, when attracted by one magnet, is without the



direct field of the other magnet. A spiral spring 14 serves to keep the armature in the one position or the other as soon as the contact is broken between the contact-pieces 18 and the binding screws 16. The battery D is thus in an "open circuit," in which the current is only momentarily used. The disc of the valve A is shown raised from its seat; the chamber K not being expanded since there is free egress for its contents through the pipe *m* and the exhaust nozzle 11; whilst the arm 8 of the disc 5 prevents the entrance of compressed fluid through the nozzle 10 of the pipe E. If now the thermostatic strip in C makes contact with the left-hand terminal, the left-hand magnet 2 will be magnetised and attract the armature 4, and the disc 5 will be operated to close the exhaust nozzle 11, and to allow the compressed fluid from the pipe E to pass through the pipe *m* into the chamber K, so as to force up the diaphragm, and by means of the lever *g* to close the valve A. (*Sealed September* 24, 1886).

8616. O. F. Jonsson, Stockholm. Galvanometer. [6*d.* 4 *Figs.*] July 1, 1886.—This improved galvanometer for measuring electric currents is very sensitive, but may be placed near foreign electric currents without being subject to wrong indication. The instrument comprises a bobbin E, the coils of which are connected to the binding screws B, C. The core of the bobbin consists of a fixed portion F, and of a movable portion or

Fig. 1. *Fig. 2.*

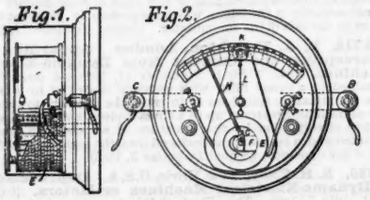


plate I partly clasping the fixed core F and fixed to a small shaft G which carries a hand H. As long as the instrument is not traversed by any current, the plate I keeps close to the core F. But if a current passes through in the direction indicated by the arrows, the core F and the plate I becoming magnetic, will repel each other so as to cause the hand to move along the scale K. A suspended weight L serves to indicate the perpendicular position of the instrument. (*Sealed November* 9, 1886).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

BRIDGES AND CULVERTS; EASTERN AND MIDLANDS RAILWAY, CROMER EXTENSION.

MR. WILLIAM MARRIOTT, ENGINEER.

(*For Description, see Page* 30.)

Fig. 1.

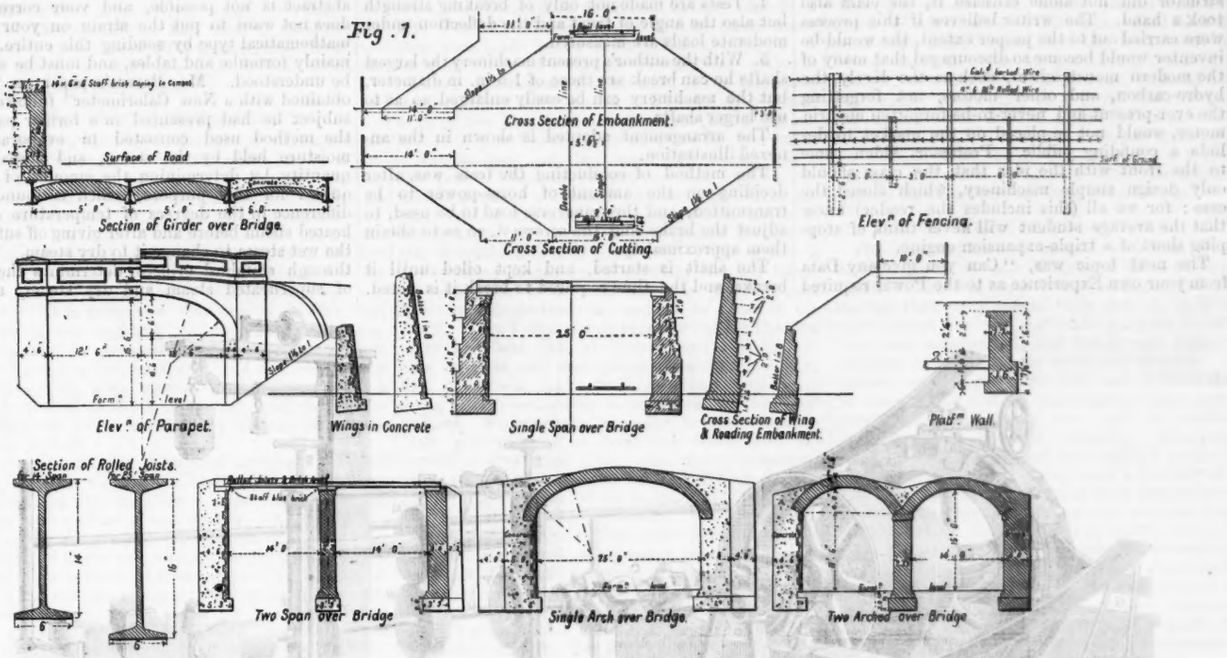
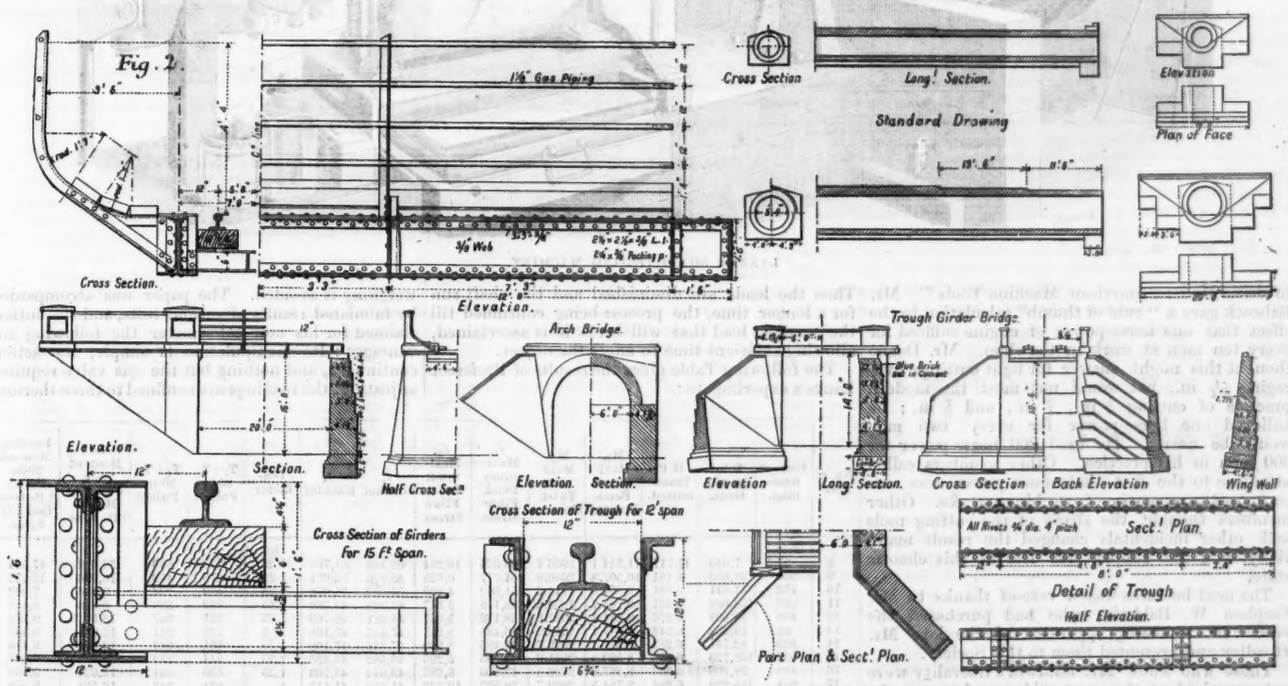


Fig. 2.



THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(FROM OUR NEW YORK CORRESPONDENT.)

(*Continued from page* 6.)

"How should a Laboratory of Mechanical Engineering be Equipped?" This is usually a question determined by the bank account of its owner, but the reckless methods suggested by the speakers might have caused even Jay Gould to shiver. The drift of thought seemed to indicate that it should have every available means for making tests.

Professor Lanza, of Massachusetts Institute of Technology, who has one of the most thoroughly equipped mechanical laboratories in the world, was evidently drawing on his own experience, for he desired steam engines, boilers, dynamometers, indicators, gauges, &c. The whole action of this admirable institution lies in the direction indicated. If a student wants to understand a loom, there is one in actual operation to be studied; if the subject desired is a blast furnace, there is a small one at work; and so in every department; it is practical as well as theoretical. So when Professor Lanza, who is a small man, desires to break a floor, he builds one and breaks it. Mr. Towne, whose experience is very great, thought young men should not be taught to do special work, but have principles instilled into them, so as to teach them to investigate any subject. The motto of the Democratic party in the United States has always been "Principles and not men," and the writer, who is a Republican, thinks no party needs principles more. From the previous topic it was a natural step to the next one, viz.: "What are the best Problems for Students in Mechanical Engineering in the last Year of their Regular Course?" One speaker thought they should be taught designing and then the instructors should show them the faults of such designs. Evidently this person had no consideration for instructors. This process would be analogous to one in the writer's experience while a student at the School of Mines. It being desired to put sufficient ammonia into a solution to produce a reaction, the writer asked the instructor to smell it to see if there was sufficient. The instructor, who was a German, replied, "I say every time, Yes; I have not yet sold my nose to the School of Mines." This would undoubtedly be the result of asking professors to criticise designs by students and to point out their defects. Professor

Lanza did not approve of too extensive designing by students. At the Institute of Technology students designed a boiler complete (the writer, who knows Professor Lanza, does not believe he would be willing to use this design without doubling his life assurance) and line shafting, &c., but the instructor did not alone criticise it, the class also took a hand. The writer believes if this process were carried out to the proper extent, the would-be inventor would become so discouraged that many of the modern monstrosities, such as the Keely, the hydro-carbon, and other motors, not forgetting the ever-present and never-to-be-forgotten electric motor, would not be placed on the market to delude a confiding public. Professor Alden came to the front with the idea that the class should only design simple machinery, which closed the case; for we all (this includes the reader) know that the average student will never think of stopping short of a triple-expansion engine.

The next topic was, "Can you give any Data from your own Experience as to the Power required to drive Modern American Machine Tools?" Mr. Babcock gave a "rule of thumb" calculation to the effect that one horse-power of engine sufficed for every ten men at work in the shop. Mr. Doane thought this might answer for light cuttings averaging $\frac{1}{4}$ in., but would not meet the modern practice of cutting $\frac{5}{8}$ in., $\frac{3}{4}$ in., and $\frac{7}{8}$ in.; he believed one horse-power for every two men would be nearer. He used 200 horse-power for 300 men in his practice. Other members called attention to the fact that much power was now consumed in operating fans, blowers, &c. Other members thought the shape of the cutting tools and other incidentals changed the result materially, and the subject was left in this chaotic state.

The next business was a vote of thanks to Mr. Stephen W. Baldwin, who had purchased the entire set of testing apparatus of the late Mr. Hoadley and presented them to this Society.

Those who know Mr. Baldwin's liberality were not surprised at this new evidence of it, but the recollection of his many services already rendered to the Society caused the passage of the resolution amid great applause.

Strength of Shafting.

Professor Lanza then read his paper entitled "The Strength of Shafting subjected to both Twisting and Bending." The author did not know of any experiments which took both the forces into consideration at once, hence he proceeded to make them.

The principal points of the method of procedure are the following, viz.:

1. The shaft under test is in motion, and is actually driving an amount of power which is accurately measured on a Prony brake.

2. A transverse load is applied which may be varied at the option of the experimenter, and which is weighed on a platform scale.

3. It is intended to adjust the proportion between the torsional and transverse loads to correspond with the proportion between the power transmitted and the belt-pull sustained by a shaft in actual use.

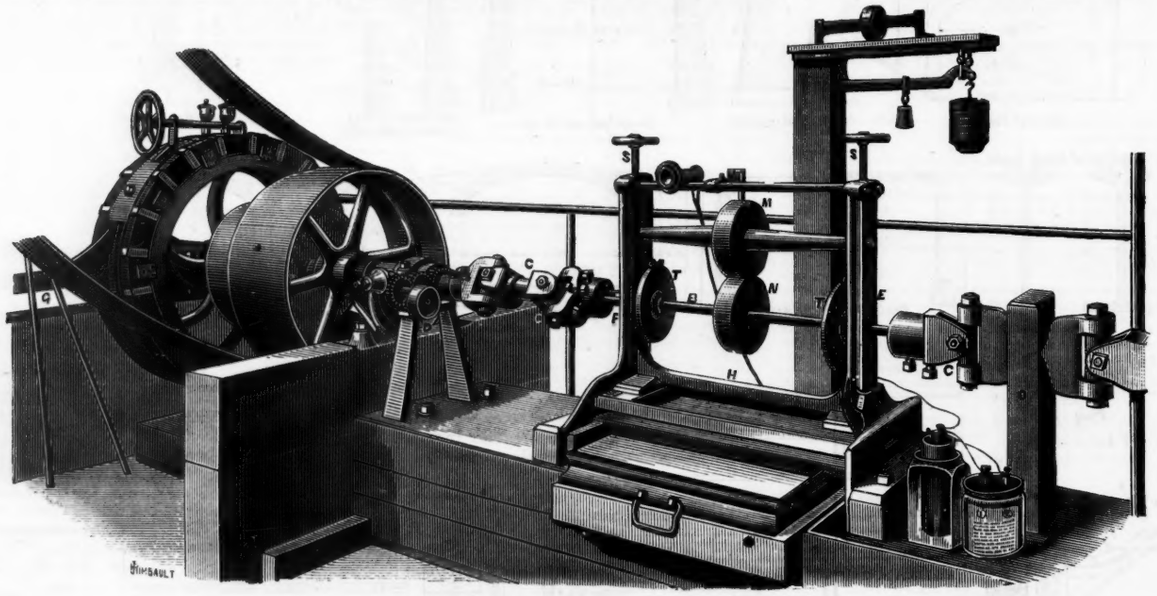
4. Tests are made not only of breaking strength but also the angle of twist and the deflection under moderate loads are measured.

5. With the author's present machinery the largest shafts he can break are those of 1.5 in. in diameter, but the machinery can be easily enlarged so as to use larger shafts.

The arrangement adopted is shown in the annexed illustration.

The method of conducting the tests was, after deciding on the amount of horse-power to be transmitted, and the transverse load to be used, to adjust the brake and the screws S, so as to obtain them approximately.

The shaft is started, and kept oiled until it breaks, and the time required to break it is noted.



LANZA'S SHAFT-TESTING MACHINE.

Then the loads are diminished and the shaft run for a longer time, the process being continued till the smallest load that will break it is ascertained, allowing sufficient time to effect the object.

The following Table gives the results of Professor Lanza's experiments:

No. of Test.	Time of Running.	Total Revolutions.	H.P. Transmitted.	M_1, Maximum Bend. Moment	M_2, Maximum Twist. Moment	f_1, Maximum Bend. Fibre Stress.	f_2, Maximum Twist. Fibre Stress.	f_1 Grashof.	f_1 Rankine	Diameter.	T_1+T_2 20-in. Pulley.	T_1+T_2 30-in. Pulley.	Bending Moment 20-in. Pulley at Middle 8-ft. Span.	Bending Moment 20-in. Pulley 2 ft. from End 8 ft. Span.
	min.									in.				
8	37.5	7,040	11.717	11,514.1	3926.4	60,024	10,234	62,168	61,755	1.25	973	649	23,352	17,514
9	200	38,839	8.181	10,507.8	2656.8	54,777	6,925	55,876	55,671	1.25	679	453	16,296	12,222
10	162	31,641	5.291	9,891.0	1714.6	51,562	4,469	52,062	51,976	1.25	439	293	9,136	7,902
11	553	108,002	4.331	9,241.7	1399.2	48,179	3,647	48,539	48,769	1.25	359	239	8,616	6,462
12	408	80,694	6.276	9,241.7	2027.6	48,179	5,287	48,911	48,769	1.25	521	347	12,504	9,378
13	98	19,333	6.342	8,917.1	2028.2	46,485	5,287	47,245	47,106	1.25	526	351	12,624	9,468
14	423	82,741	6.283	8,917.1	2029.7	46,485	5,290	47,246	47,106	1.25	521	347	12,504	9,378
15	565	108,739	6.192	8,592.5	2031.6	44,793	5,295	45,582	45,436	1.25	514	343	12,336	9,252
16	443	88,208	6.338	8,267.8	2026.8	43,100	5,283	43,914	43,763	1.25	526	351	12,624	9,468
17	951	185,233	6.283	3,781.5	2029.7	38,503	10.233	41,768	41,117	1	521	347	12,504	9,378
19	..	..	14.334	8,268	4744	84,185	24,152	91,928	90,368	1	1231	821	29,544	14,158
20	..	..	7.562	7,976	2394	82,112	12,188	84,819	83,031	1	628	419	15,072	11,304
21	..	..	9.972	8,917	3232	90,793	16,454	94,434	93,716	1	828	551	19,872	14,904
22	..	..	15.159	8,917	4848	90,793	24,681	98,612	97,103	1	1258	839	30,192	22 644
23	..	..	2.955	7,652	945	77,913	4,811	78,314	78,239	1	245	163	5,880	4,410

The author concluded from the above, that in most cases where shafting is used to transmit power, breaking is more liable to occur from bending than twisting. In regard to the twist under moderate loads, the following modulus of elasticity for torsion was obtained as the average of nine experiments on 1 in. shafting, 12,341,811; while the tensile modulus of elasticity was 27,008,621 lb. per square inch. The theoretical shearing modulus of elasticity is 11,603,448, not far from the average value as determined by these experiments.

Reciprocation in High-Speed Engines, and a New Calorimeter.

Professor Alden's paper on "Formulæ and Tables for Calculating the Effect of the Reciprocating Parts of High-Speed Engines" was read, but an abstract is not possible, and your correspondent does not want to put the strain on your fount of mathematical type by sending this entire. It was mainly formulæ and tables, and must be studied to be understood. Mr. Barrus's paper on "Results obtained with a New Calorimeter" followed. This subject he had presented in a former paper, and the method used consisted in evaporating the moisture held by the steam, and measuring its quantity by determining the amount of heat required for that purpose, which is found by the difference in the degrees of temperature of superheated steam before and after giving off sufficient to the wet steam to change it to dry steam. The flow through standard orifices determines the amount of superheated steam and dry steam, and thus weighing is avoided. The paper was accompanied by tabulated results of various tests, and the author claimed for his new calorimeter the following advantages: Its manipulation is simple, its action continuous, and nothing but the gas valve requires adjusting, the readings are confined to three thermometers and the steam gauge, and the temperatures need not be taken with that accuracy demanded by the usual form of water calorimeters. The tables showed great uniformity of result.

Topical Discussions.

The next topical discussion was taken up, "What are the best Conditions for Flying Rope for Transmission of Power, and are there Limitations to its Use?" There were various views expressed, evidently some members had flown rope, and did not

want to do so again. One man told the writer it was just a little bit the meanest way to transmit power he knew of. At Cornell University, it seems, power was transmitted 1100 ft. by means of a ⅝-in. rope, and after looking for a long time for the cause of the excessive vibration, it was decided to have the rim of the wheel and the grooves turned true and the wheel rebabbitted, which obviated the trouble. Mr. Giddings had used it successfully; employing 1¼-in. manilla for transmitting 25 horse-power 250 ft.; he lined the grooves with alternate layers of rubber and leather.

THE NEW YORK EXCURSION.

The meeting then adjourned to visit that historical gallery and receptacle for the lost arts known as the American Institute Fair, which is annually held in New York City. Whenever an invention having an impossible future is found, it is promptly transferred to this place for fear of losing it, so also old machinery may be found on every side, and if it was not for this institution the mechanical engineers would never become familiar with the progress of mechanics. It is rumoured that one of Noah's first studies in ark building will be obtained at any expense and be presented to the country patrons for "Studies in Shipbuilding." It will be flanked on either side with mammoth pumpkins, with a background of tremendous turnips, and the apples of Eden will be in front, being objects of equally ancient history.

And now, having consumed midnight gas and other kinds as well, it was designed to have a day of relaxation with the view of improving the minds, bodies, and estates of the Society. Accordingly a trip to Newark, New York, was planned, stopping at Bedlow's Island and visiting the Bartholdi Statue. It had been announced that the boat must start at 8.30 A.M., and she would go whether the party were on board or not, ergo, the party were there, and they were at first sight a rather sleepy lot, but it was seen later that this attitude was simply assumed, and the "eye-openers" began to awaken them.

The day, which had been threatening, began to clear, and the anxious minds, that had passed resolutions condemning the Signal Service for not doing better for the Engineers, became quiet and happy, so we steamed rapidly down the beautiful harbour, and landed at the Statue of Liberty, where the party was welcomed by the United States officer in command, who promptly sent up to stop the rivetters who were at work inside the statue, lest they might incautiously permit a trial of resistance between the head of the rivet and the head of some distinguished engineer, or still worse crush in a full style of hat on the head of some one of our fair guests.

The permanent staircase is not yet entirely erected, but a temporary wooden one runs up to the top, and this Society had the distinguished honour of being the first party who had made the ascent. One or two went up the arm to the torch, but this involved a hard and somewhat dangerous climb, and was promptly stopped. Some 150 went to the top of the statue, and we found ourselves rewarded by a most exquisite view. The crown of Liberty, like all crowns in the United States, is a symbol of regard and adoration rather than of power, for the power she wields is that of love, hence she permits her guests to stand on her brow and gaze through the crown which is built open for that especial purpose. As the statue has already been thoroughly described in your columns, it only remains to say that no one realises its great beauty and grandeur until they have regarded it from every point of view and have actually grasped a full idea of its proportions by climbing to the top. After embarking, the steamer took a course which permitted a view of the full face from the water, and this is really the most favourable position in which to view her, as no doubt the great sculptor intended it should be. The noble features gaze down on the beholder with a mild majesty at once thrilling and commanding. There are blended sympathy for the oppressed and stern justice for the oppressor, and she stands there at the gate of our greatest commercial city holding aloft the torch which "enlightens the world." But Newark was our destination and we were soon there, being met on landing by the genial mayor, whose interest in everything local is well known and who takes a just pride in the city he governs. The manufactories of Newark are seldom realised by those who have not visited them, for the city is over-shadowed to some extent by its proximity to New York (nine miles). Yet the population at present is 150,000, and it will probably be 250,000 in the next five years. It is most decidedly a manufacturing city, and (what many even of the Mechanical Engineers do not know) has turned out some of the finest mechanical work ever made, tools of the most delicate and exact nature, which will cut always and accurately 200 threads to the inch. Many of these were afterwards examined by the visitors in Mr. Weston's laboratory, and few of them knew they were made but a short half-mile distant. A large quantity of "foreign jewelry" is made in Newark; the delicate filagree work of the Mexicans, the Mosaics of the Romans, and the finely coloured work of the Etruscans are all made here, and imported to New York City for sale, and fine specimens of the ancient art they are. The writer has a fine pair of Japanese sleeve buttons, and he obtained them at a Newark factory. Beautiful ancient brasses are also made here, which are even better than the originals, and Russia leather is also a product of this great city. The writer is not speaking ironically of anything but the titles, for the work is as well done as possible, and Newark manufactures are second to none in the world, as we found out during our visit. The first place seen was that of Hewes and Philips, engine builders, and there much beautiful machinery was examined, and their thorough system of doing work favourably commented on by their visitors. From there we went to the Armoury Hall and enjoyed a bountiful feast, and the topical query arose then and there, numbered twenty-nine on our list, viz.: "Which do you prefer, a feed pump or an injector?" The answer has not cleared the difficulty, but that could not be said of the tables; the keen air of the bay had sharpened every one's appetite, and the food was of a most appetising character, hence the tables were cleared and re-filled time and again until all were satisfied, and in that state were taken to the United States laboratory to witness the great inventions made by Mr. Edward Weston, a member of the Society, and one of the most distinguished electricians of the day. It is due to his wonderful mind and great ingenuity that the electric light in the United States occupies the position that it does. The writer has had the pleasure of seeing Mr. Weston's methods of reaching a result, and he is most eminently analytical and differential. He diagnoses an investigation by analysis into all its possible and probable cases, and proceeds to eliminate them one by one until he reaches the true solution. Having reached this there are no failures, for the practical result which has been patiently worked out, is thoroughly reliable. It was just this method which produced "tamadine" for making the filament in the electric light. Mr. Weston wanted to obtain a homogeneous material, and he found it; then he threw into the process his mechanical and chemical knowledge, and now this material is readily made and the filament constructed by operators who only know the plain manipulation. These works were not long since described in your columns, hence nothing further need be added in this article; suffice it to say, they proved so extremely interesting to the visitors, that it was with greatest difficulty they were started from them one hour after the allotted time, and taken to Watts, Campbell, and Co.'s works, where they were again treated to a sight of beautiful mechanical work, and shown how to construct a fine and perfectly working engine. It was again with great difficulty they were persuaded to leave this interesting place for the Clarke Spool Thread Works, an enormous building which, having outgrown one side of the Passaic River, has promptly extended itself to the outer side. There were many ingenious and interesting machines shown to us here, and not the least interesting to some of the younger members, and it must be said to many of the older ones, were the bright-eyed and roguish-looking girls who attended them. When one factory hand can detain three grey-haired veterans in the explanation of a most simple piece of mechanism, what can be expected of the younger members who are able to produce the plea of ignorance as an excuse for lingering? At last all were started for Mr. Weston's private laboratory, which is probably the most complete in the world, and has been visited with delight by many engineers from your side of the water. There are really four laboratories under one roof, the physical, the electrical, the mechanical, and the chemical. This building was called into existence by the demands made on this distinguished engineer for private consultation and experiment. No pains or money have been spared in its fitting up, and everything bears witness to the master mind which conceived not alone the general plan, but each particular detail. It seems to the visitor as though every emergency had been provided for, and Mr. Weston's private practice has grown to such proportions as to absorb almost his entire time. Much time could have been spent here with great profit and pleasure, but the boat must leave before dark in order to get through the drawbridges, of which there were four, without delay. The captain was found in a great state of mind, vowing we stood a good chance of remaining on board all night, but his fears were unfounded, and we reached New York City about 7 P.M., after having a fine view of Liberty with the torch and electric lights around the base in full blaze.

THE VALUE OF SPECIAL TOOLS.

The evening session opened with Mr. Oberlin Smith's paper on the "Intrinsic Value of Special Tools." This was a question of economy, and noted the fact that many special tools were of little or no value except for the particular purpose for which they were constructed, and hence were difficult to estimate on in taking an inventory of value. Mr. Smith's conclusions were that such articles should be rated at the cost of reproducing them less depreciation by wear and tear, and an additional diminution for obsolete character. The amount of this last feature formed the principal point in the paper. He favoured laying aside a portion of the extra profits which these tools have earned by their special usefulness in the general reserve fund of the concern, so as to save the necessity, in case of an inventory, to tell the stockholders that tools which had cost 100,000 dols. at the outset were worth no more than 50,000 dols. Various members gave their views, one advocating 10 per cent. depreciation on standard tools and 20 per cent. on special ones. In brass patterns 20 per cent. was recommended.

CAPITAL AND LABOUR.

Mr. Partridge's paper on "Capital's Need for High-Priced Labour" was a well-written and well-argued document, but the principles underlying it will not meet with favour at the hands of the labour agitators and trades unionists. He looked rather to co-operative establishments; but should this be brought about, what would become of the "walking delegates" and "master workmen" who have no other source of livelihood than the money they extort in small quantities from the hard-working dupes who are too busy earning it to see where it goes? It has been remarked that a tax of 25 cents per week from the mechanic will enable the "master workman" to go through the rigours of the coming winter in comfort.

(*To be continued.*)

THE NATURAL HISTORY OF LOCAL BOARDS.

III.—THE FIGHTING BOARD.

(*Continued from page* 3.)

THE rejected design showed more decision, and discarded the idea of a river-side source. A careful investigation had demonstrated to the author that there existed a proven connection between the water tubbed off in the coal-shaft, and certain deep wells on that side of the village next to it. He got the borings and compared the sections; and then without the least doubt or hesitation located his site in a line almost direct between the two. The cost of the accepted scheme was to be about 6000*l.*, and that of the rejected scheme 3500*l.*; a circumstance which of itself commended the strange engineer to the economic ideas of the malcontents, who still prosecuted the opposition; though it is highly probable that, like all water engineers, he would have asked for more.

A Local Government inquiry was held, at which both the Board and their opponents were represented. Cross-examination discovered weak points in the Board's scheme, and evidence was given by the opponents showing that the existence of a geological fault, whose continuity in this direction was held to be very certain, would cut off the great underground stream of the valley from the proposed site of well. When, however, the merits of the rejected design were about to be raised, the inspector at once put his foot upon it, by refusing on Parliamentary precedent to enter into the question

BRIDGES AND CULVERTS; EASTERN AND MIDLANDS RAILWAY, CROMER EXTENSION.

MR. WILLIAM MARRIOTT, ENGINEER.

(*For Description, see Page* 30.)

Fig. 3.

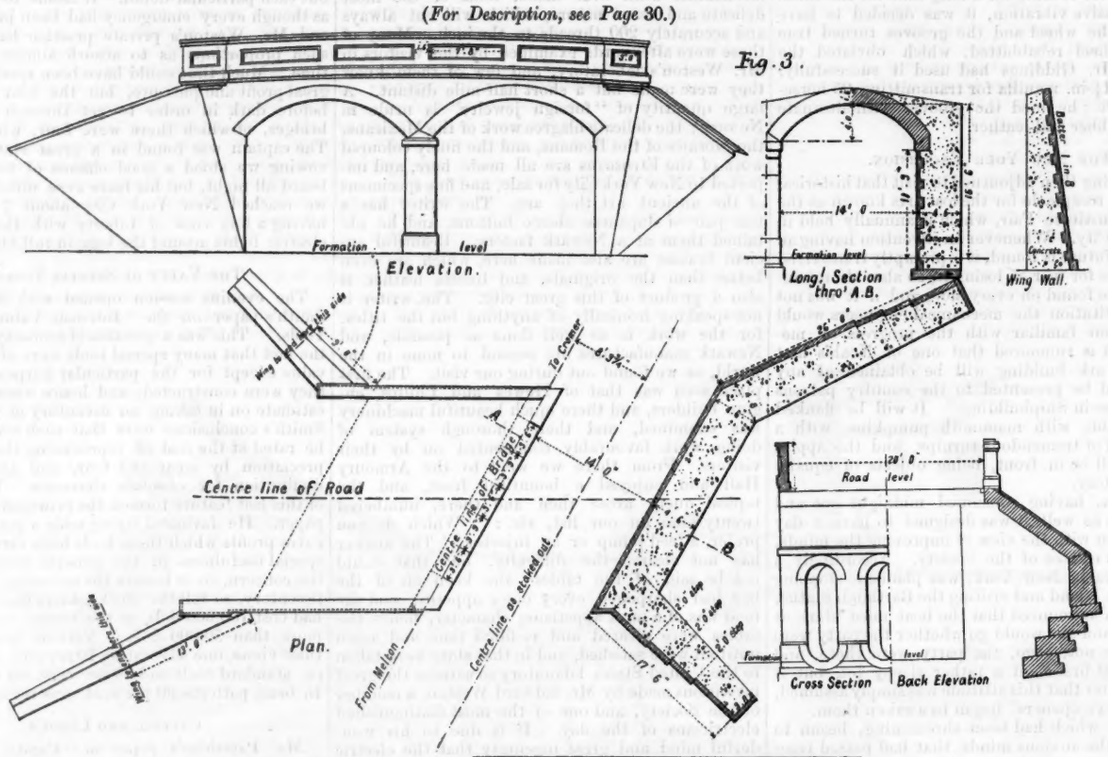
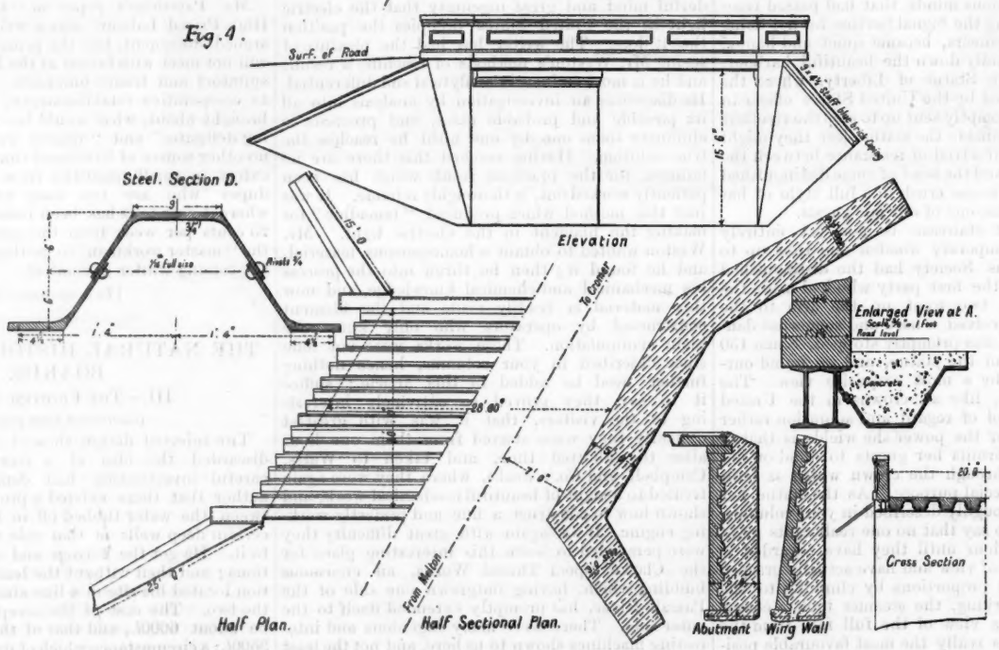


Fig. 4.



of any alternative scheme, considering it was his duty to keep himself in a state of darkness as to the resources of the district other than those officially laid before him. The opposition were staggered at this unlooked-for stroke, which took the heart out of their case, and henceforward the result was regarded as a foregone conclusion; and so it proved, for in due time the Board's scheme received the Government's sanction.

But they paid dearly for their triumph, while the opposition had the grim satisfaction of the man who predicts his neighbour's misfortunes. From beginning to end, the water scheme was a history of disasters and failures. First, the contract for the well-sinking was let at nearly thrice the estimate, and cost more. Then the water, when got, proved brackish, containing so much common salt as to be nauseous; and the indignant ratepayers flatly refused to drink it, no matter how thirsty they were and how much it had cost. So a new boring was made further up the slope, coming nearer to the line of the colliery stream, but in vain. Then a further advance was made and signs of clear water found, until finally, after a fruitless outlay of several thousands of pounds, and many years after the engineer had said good-by to his clients, the long-sought water was found within a few rods of the site selected by the strange engineer; hard enough, it is true, but clear and potable, and greeted with satisfaction by the much suffering ratepayers.

Then the roof of the service reservoir was no sooner finished than it proved too heavy for the foundation of its pillars, which, giving way, caused the whole to collapse. Now was their patience exhausted; and having disbursed nearly double the estimated cost without getting the water they sought, the Board turned obstinate, buttoned up their pockets, and refused to re-cover the tank—which accordingly to this day remains open to the sky—and soon wound up their engineering advice.

But the Board had not been entirely idle during the seventeen years of its waterless existence. A burial ground was provided with lodgings more dry and salubrious for the dead than those now occupied by the living. Another excellent thing was also done, viz., the provision of a public market ground at a cost of 2500*l*. True, it was open and exposed

BRIDGES AND CULVERTS; EASTERN AND MIDLANDS RAILWAY, CROMER EXTENSION.

MR. WILLIAM MARRIOTT, ENGINEER.

(*For Description, see Page* 30.)

Fig. 6.

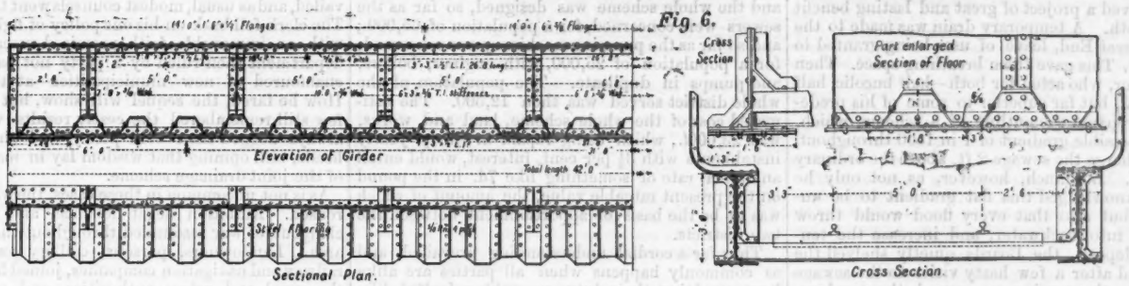


Fig. 7.

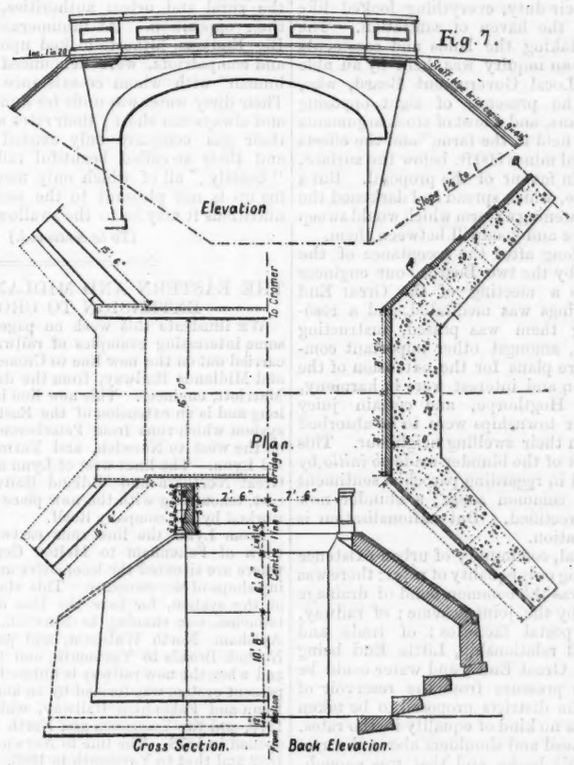
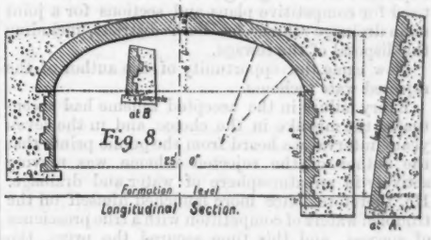


Fig. 8.



to the elements, which converted its unpaved sod into a quagmire on wet market-nights; but there was no other market within three miles, and it gradually improved until it became a prosperous fair, thronged by busy customers from all the surrounding villages.

Meanwhile, they had met with a chequered experience in the way of surveyors—a mysterious profession without a diploma, which, while it numbers amongst its ranks thousands of good men, is undeniably the refuge of broken men of every class. Great End suffered the common fate of small districts, dismissing a few incompetents in quick succession, while a disbanded Ordnance civil assistant robbed them and fled the country. If they lighted upon a good man he was soon translated to a better sphere. Like a watch, the engineer is difficult to get to work well in little space at a little price; and when they do get him by some miraculous chance, few Boards know they have him until he is gone.

No scheme of drainage had been carried out, for, as usual where rates are concerned, and where nothing showy is to be seen for the money, the Board remained quite content with their latent powers, without turning them into Acts. A length of drain was put in here and there to suit the exigencies of those who had force or influence to move the powers that be, but nothing further. At last, however, not long after the long-delayed completion of the water works, a crisis was reached, and the fighting powers of the Board, hitherto exercised in petty skirmishes in the local courts, found a nobler field in a great Chancery suit, the first of a long series of exploits in that direction which made the name of Great End famous in local annals.

It will be remembered that a low swampy region, with a forlorn colony of workers lost in filth and disease, bordered the district on the up-stream side, and was recommended to be incorporated with it by the Commissioner who presided at the first inquiry. This colony had now expanded into a second and more dismal Great End, and had its own Local Board. The boundary line between them was a ditch, which in dry weather received nothing but a part of the sewage from both districts. It was a mere sluggish creek invaded in times of flood by backwater from the river, and having no fall or efficient discharge, the sewage stagnated into a deadly nuisance. The landowner—a county magnate—took umbrage, and stood upon his undoubted rights as the owner of a watercourse, and not of an open sewer or cesspool. The Board's solicitor, who, among other great qualities, possessed that of invincible tenacity, acted for both authorities, and having but one method, counselled resistance. Thus began a feud which, begetting others in natural sequence, became the father of an Iliad of lawsuits, costs, and special rates, the exact history of which would give scope to the inspiration of Homeric genius.

The war was commenced by affidavits containing the customary allowance of hard swearing, and at every stage the Board, although defeated, fought on until an injunction was obtained, accompanied by a bad quarter of an hour to the defendants' advisers; an injunction restraining the said defendants from polluting the plaintiff's watercourse. What followed is one of the most curious things in the curious annals of local government. Like any well-conditioned acorn, this injunction held within itself the future of a goodly tree—the sturdy trunk, the vigorous boughs, and the rich harvest of leaves and fruitage—a tree of litigation which, striking its roots and suckers deep into the vitals of the community, drew thence its sustenance for many a long year.

By a singular process of logical induction, the Board persuaded themselves, or were persuaded, that inasmuch as the law disallowed their claim to pollute their neighbour's stream with their ratepayers' sewage, they themselves could disallow their own ratepayers' claim to discharge the offending sewage into the public sewer by which said pollution had arisen. Accordingly, without loss of time, they gave notice to a certain maltster, who had not gained the love of the Board, to cut off his drain from the sewer in question, failing in which they gave him short shrift, and in a moment of temporary insanity, themselves did the deed by stopping up his outlet. By which masterly device they not only stopped his drainage, but his business also, for being deprived of its outlet, his refuse liquor, mingled with sediment and grain husks, backed up the branch until it rose strong and rank, and flooded the floor of his kiln, destroying much malt, and creating as fine a specimen of matter in the wrong place as even Great End could present.

Of course the *ultimo ratio* of the aggrieved maltster was the law, and to law he vigorously betook himself. A second Chancery suit followed, in which the Fighting Board were defeated at every point, and another injunction obtained restraining them from stopping the very sewer which before they had been restrained from discharging into the watercourse. Thrust into a corner, there was only one desperate resource before them, to wit, the doing of that which they were called into existence for the express purpose of doing—the making of a main intercepting sewer, of which more anon. The Chancery suit did not end here. The Board with all their fighting power stoutly resisted the claim of damages which swiftly followed the Vice-Chancellor's decision, and were again signally worsted; the amount of damages was then disputed, and finally referred to arbitration, after which ensued a stubborn conflict over taxed costs, which closed this memorable contest of many years' duration over dirty water; the epilogue being the levying of special rates for the payment of damages and costs, amid the murmurs of their mutinous constituents. This result was the beginning of the downfall of their solicitor's power, and it was openly said by malcontents that the Board's legal advice was not always illumined by what the great Lord of Verulam called dry light.

Coming back to the great drainage question, it

must be stated that their neighbours and partners in the first Chancery suit, whose territory may fitly be called Little End, were in the same plight with themselves, and wanted an outlet. Common adversity makes communities friendly as well as individuals; so the two Boards wisely joined hands and conceived a project of great and lasting benefit to them both. A temporary drain was made to the river by Great End, leave of user being granted to Little End. This gave them breathing space. Then the surveyor, who acted for both—half bucolic, half professional, but far superior to some of his predecessors—prepared the outline of a scheme, which, by the impossible gradient of 1 in 1500 throughout, would discharge the sewage 2 ft. above the ordinary river level. Inasmuch, however, as not only he himself acknowledged this flat gradient to be undesirable, but also that every flood would throw the outfall into backwater, and increase the tendency to deposit, the Boards quietly shelved the scheme, and after a few hasty visits to the sewage experiments then going on around them, advertised for competitive plans and sections for a joint main drainage scheme for both districts, including the disposal of the sewage.

Now came the opportunity of the author of the rejected water scheme.

Every failure in the accepted scheme had accentuated the mistake in the choice, and in the seven years' interval we heard from the public prints that the author of the rejected scheme was moving actively in an atmosphere of water and drainage. He, therefore, once more launched himself on the troubled waters of competition with a true prescience of success, and this time secured the prize, the scheme being unanimously accepted by the two Boards. As we are dealing with the natural history of Local Boards, and not with the science of engineering, we do not feel called upon, even if we were capable, to render elaborate and exact technical details, and will simply present our readers with a very brief outline of the successful design.

The two districts sprawled along the southern margin of the sluggish ponded rivers for a length of four miles, hugging it in many a curious link, of which two-thirds belonged to Little End, and one-third to its neighbour. The former was big enough to possess two centres of population; the one being the ancient village or hamlet, now garnished with an outlying mining suburb of the usual kind, half St. Giles and half Dingley Dell; and the other, by far the more important, the low-lying colony which lay at the feet of Great End, and, as already said, its overflow. Between these two centres lay a great stretch of land purely agricultural, flat and uninhabited, and likely to remain so, being chiefly in the hands of one great landowner. Dividing the twain, although of one parochial flesh, our engineer devised a separate scheme of drainage, pumping, and irrigation for the old village; a 12 in. pipe, with a gradient of 1 in 250, being intended to take the whole of its sewage.

Then joining the urban section of the community to its real parent, Great End, he set aside the notion of natural fall, which was really not more than about 2 ft. to the mile, and designed a joint main outfall sewer extending parallel with the river to a point at the lowest extremity of Great End; at which point, from a depth of 11 ft. below the natural surface of the flooded land, the sewage was to be lifted 55 ft. by pumping engines on to high ground just without the district, there to be distributed by natural filtration on 12 acres of good land specially prepared by deep drainage. No settling tanks were proposed, the sewage being of a thin diluted kind, almost void of manufacturing tribute, and from an almost closetless town; besides which, it was thought that if such were found necessary by experience, the omission might readily be made good at any future time. A broad shallow pool was to be made at the mouth of the effluent conduit, whereby the regularity of the water could be proven, with gauges for testing the inflow of sewage and outflow of clear water.

Even with this division into two independent sections, and with the artificial fall into the bargain, the gradients were flat, ranging from $\frac{1}{600}$ to $\frac{1}{1250}$, the sizes of sewers also varying according to the required duty, the largest being 30 in. by 20 in., which is explained by the fact that after a careful consideration of all the circumstances, our engineer decided to separate the bulk of the top water from the sewage proper; knowing that in any case some of it, as well as subsoil water, would find its way into the sewers. By this means he proposed to secure economy and regularity in pumping; regularity of flow and quality for treatment; comparative freedom from sludge; and, lastly, economy in construction; huge underground channels for storm water being avoided. To obviate night pumping, a tank sewer, 6 ft. in diameter, was provided; and the whole scheme was designed, so far as the sewers were concerned, for a population of 65,000; and so far as the pumping machinery was concerned, for a population of 25,000, with engines, boilers, and pumps in duplicate. The population of the whole district served was then 12,500. The estimated cost of the whole scheme, land and works, was 23,000*l.*, which being repaid in thirty yearly instalments with 3½ per cent. interest, would entail an annual rate of something like 7d. in the pound on the present rateable value, the amount of which was to be the basis of apportionment between the two districts.

Thus far a cordial understanding prevailed, and as commonly happens when all parties are alike bent on doing their duty, everything looked like plain sailing into the haven of sanitation. The usual notices for taking the lands and easements were issued; and an inquiry was held by an able inspector of the Local Government Board, who, notwithstanding the presence of eight opposing counsel and solicitors, and a host of stock arguments about "the finest field in the farm," and the effects of "miasma" to coal mines 500 ft. below the surface, reported entirely in favour of the proposal. But a sudden cloud arose, which spread and darkened the two districts, threatening a storm which would sweep into space all peace and goodwill between them.

One day, not long after the acceptance of the drainage scheme by the two Boards, our engineer was summoned to a meeting of the Great End Board. Great things was meditated, and a resolution embodying them was passed, instructing the said engineer, amongst other important commissions, to prepare plans for the extension of the district. Ambition and interest were in harmony, and Little End, Hogthorpe, and certain juicy slices of two other townships were to be absorbed and made one with their swelling neighbour. This was the first result of the blunder made *ab initio* by the General Board in regarding parochial sentiment as paramount to common sense; a blunder now proposed to be rectified. But nationalisation is easier than annexation.

In every essential, community of urban existence was there, excepting only equality of rates; there was the rub. There was the common bond of drainage exigency, sealed by the joint scheme; of railway, navigation, and postal facilities; of trade and markets; of blood relationship, Little End being truly begotten of Great End; and water could be supplied with due pressure from the reservoir of the latter to all the districts proposed to be taken in. But there was no kind of equality in the rates. Great End stood head and shoulders above the rest in the tax-gatherer's books, and that was enough. In this key the shrill note of alarm was sounded, rousing the master-passion, and arraying the whole of the threatened townships in arms against the aggressor. But the Bismarcks of Great End took little heed of this. Trade was moving up by leaps and bounds in that fine frenzy which entraps great financiers, and frightens dull men, who think that business intoxication is followed by the inevitable "next morning;" and vainly trusting in the strength of their case, they already exulted over their approaching victory. Our engineer, who had fought many a good fight in this field, and knew that kissing goes by favour, was not so sure, but prepared the needful plans and evidence with that clear conscience always brought by a strong client and a strong case. But as the long-deferred inquiry drew nigh, a new consequence of original sin broke out, giving him food for serious reflection. This was no other than the secession of Little End from the joint drainage scheme.

Stung by the unbending attitude of their domineering neighbour, and urged by advisers of the school of Machiavel, the Little Endians, who ought never to have had a separate corporate existence, took a desperate step, and probably as a last resource, to secure the withdrawal of the annexation scheme, tore up their own bond, thus unwarrantably breaking faith; whereupon the Fighting Board took counsel amongst themselves. The more cautious suggested the withdrawal of the extension scheme on condition that the Little Endians honestly returned to their bond; wisely contending that the completion of this would strengthen their claim on a future occasion. But when did caution avail against the enthusiasm of a community? Visions of a mayor and alderman, a common council and a town clerk, mace and chain and town hall, bench of borough magistrates, and all the august paraphernalia which follow incorporation; these prevailed, and as usual, modest counsels went to the wall. The clerk fell back on his one policy of fighting, and with an immovable faith promised success with a department then ruled by a party not particularly enamoured of new municipalities—at that time. How he fared, the sequel will show, but the sober few still remembered the costly results which had always dogged their bold policy, and shook their heads, still opining that wisdom lay in making sure of the joint drainage scheme.

As is not uncommon in these cases, the waters were roused. Ambition begat defiance, and the shrill clangour of war resounded throughout the affected area. Landowners, parsons, colliery owners, and railway and navigation companies, joined hands with the rural and urban authorities, and marshalled their opposition. At innumerable meetings, the Big Endians, hitherto looked upon as fellow-men and compatriots, were denounced as almost "anti-human" with whom co-existence was impossible. Their dirty water was unfit for human consumption, and always ran short; their rates spelt bankruptcy; their gas company only existed on sufferance; and their so-called beautiful railway station was "beastly;" all of which only meant that swallowing up is not pleasant to the swallowed, however nutritious it may be to the swallower.

(To be continued.)

THE EASTERN AND MIDLANDS RAILWAY EXTENSION TO CROMER.

WE illustrate this week on pages 25, 28, and 29 some interesting examples of railway construction as carried out on the new line to Cromer, of the Eastern and Midlands Railway, from the designs of Mr. W. Marriott, engineer. This new line is about ten miles long and is an extension of the Eastern and Midlands system which runs from Peterborough and Spalding, on the west to Norwich, and Yarmouth on the east *vid* Lynn. The lines west of Lynn are worked by the Great Northern and Midland Railways, while those east, amounting with the new piece to 114 miles, are worked by the company itself.

From Lynn the line runs eastward through the town of Fakenham to Melton Constable Junction, where are situated the locomotive and carriage repairing shops of the company. This station is the centre of the system, for here the line divides into three branches, one running to Norwich, another through Aylsham, North Walsham, and past the celebrated Norfolk Broads to Yarmouth, and the third to Holt, and when the new railway is finished, to Cromer. The present system was formed by an amalgamation of the Lynn and Fakenham Railway, which was opened in 1879, and the Yarmouth and North Norfolk Railway opened in 1878. The line to Norwich was finished in 1882 and that to Yarmouth in 1883.

The original line reached Lynn by running powers over the Lynn and Hunstanton Railway, all goods traffic having to pay mileage to the latter, as well as terminals to the Great Eastern before being handed to the Great Northern and Midland, who, as before stated, work the western sections. To avoid this expense and delay, the Eastern and Midlands Railway Company obtained powers to construct a line from Bawsey, about three miles from Lynn, over the Norwich and Ely and London lines of the Great Eastern, to join their western sections at South Lynn, where they now have their own station, engine sheds, and accommodation. This line, which is called the Lynn Loop, was opened for traffic on January 1, 1886, and has already proved a great benefit to this company's traffic. It is five miles long and double line throughout. By means of the loop the company will be able to compete most favourably for the Cromer passenger traffic from the North and the Midlands.

The new line commences at Holt, and runs for 2½ miles through a very easy country, then enters a cutting, from which some 70,000 yards of earth have been taken. From the entrance of this cutting there is an incline of 1 in 80 for two miles, which is the heaviest gradient on the whole system through a succession of cuttings and embankments; but, after this, there is but little work till near Cromer, where there is a cutting containing upwards of 80,000 yards and 40 ft. deep. As Cromer lies low and is surrounded by high ground this was unavoidable. The materials excavated were ballast, &c., and at the Holt end, chalk and marl in the centre, and a mixture of many different kinds of earth at Cromer. There are stations at Holt, Sherringham, and Cromer. In all cases the stations are close to the towns, and this will give this company a great advantage over the Great

Eastern Railway at Cromer, for the station is fully a mile away, and at the top of a steep hill very similar to the Ilfracombe station of the London and South-Western Railway. The line is single throughout, but the stations are made for double line; the platforms at Holt and Sherringham are 350 ft. long and 12 ft. wide, ample siding accommodation is provided, and arrangements made for the immediate despatch of fish by both passenger and goods trains. The platforms at Cromer will accommodate three long trains at a time, and both of them can be used for arrival or departure. The goods' yards are so laid out as to be capable of future extension, and no curve is of less than 10 chains radius for a siding, and 20 chains for a facing point junction. The radius of the curves on the main line varies from 30 to 80 chains.

The Holt and Sherringham station-houses have each a general waiting-room 20 ft. by 14 ft. with an open pitch pine roof, a booking-office 14 ft. by 11 ft., station-master's office 14 ft. by 9 ft., and ladies' waiting-room 12 ft. by 9 ft., all 10 ft. high. The Cromer Station has a hall 26 ft. square, a first-class room 18 ft. by 13 ft. 6 in., a ladies' room 14 ft. by 10 ft., booking-office 24 ft. by 7 ft., parcels office 24 ft. by 12 ft., station-master's office 14 ft. by 10 ft., and porters' room 14 ft. by 7 ft. 6 in., all 12 ft. high, and in addition a station-master's house attached and refreshment and dining-rooms with kitchen, cellar, and lavatories, and a length of 175 ft. of covered platform. The roof of this platform is of a type not often seen in England, although the same class of roof is frequently used in Scotland. It is of unequal pitch, by which means the glass is placed nearly vertical and is consequently not so prone to the usual failing of flatly pitched glass roofs, namely, leakage.

In designing the bridges and other works the engineer has been guided by the materials on the spot; having provided himself with a general idea of the work required, he had the set of type drawings prepared shown in Figs. 1 and 2, page 25, and these standards were kept to as much as possible. Owing to ballast being plentiful, concrete, with a brick facing, has been in many cases adopted for the abutments and wing walls. By reference to the drawings it will be seen that Fig. 3 is an over-bridge built for a double line with the wings shortened, as only a single line is at present required. It will be noticed that this type is very economical in headway, the rise of the arch being regulated by the loading gauge. This bridge contains some 80 yards of concrete and 250 yards of brickwork, and cost about 350*l*. The coping is of bull-nosed blue brick, and all arches are turned in cement.

Figs. 4 and 5 show an over-bridge close to a station where a double line is required. As headway here is very important, Lindsay's steel flooring has been adopted, the parapet being built on two rolled joists. From the surface of road to the soffit of the girders is but 18 in. This flooring has been adopted for the same reason to economise headway on the 36-in. span girder bridge shown in Fig. 6, page 29. The flooring is here rivetted to the girders and stiffeners, and a very neat and strong job is made. The bridges shown in Figs. 7 and 8 are very cheap, where headway is of no great importance. That with a 15 ft. roadway cost only 250*l*.

(To be continued.)

MISCELLANEA.

THE International Statistical Institute has arranged to hold its meeting in Rome in Easter week.

The French census, taken last May, shows the population of France to be 38,218,000, whereas in December, 1881, it was 37,672,000.

The First Lord of the Admiralty has appointed Mr. Charles Adrian Keith Falconer to be his additional assistant private secretary.

For the year 1886 the imports into the United Kingdom amounted to 349,381,000*l*., a decrease of a little over 5½ per cent., as compared with 1885. The exports amounted to 212,364,000*l*., a decrease of about ¼ per cent.

Sir James Kitson, speaking at the Leeds Chamber of Commerce, said, that there is an enormous demand for old rails, which are being sent over in thousands of tons to the United States. The Americans are also ordering steel blooms in large quantities.

Mr. David Halley, formerly of Messrs. Napiers, and who for the last four years has been chief engineer at Messrs. Burmeister and Wain, Limited, Copenhagen, the largest shipbuilders and engineers in Scandinavia, has been made a director of the same company.

The French Minister of Marine has sent instructions to the naval authorities at all the French ports to get the first-class torpedo boats ready for sea, and then to despatch them to Toulon to take part in the great naval manœuvres which will again be held this year.

The French Budget shows that Public Works expenditure is to be reduced from 70,000,000 f. to 55,000,000 f., while the army expenditure is to be increased by 86,000,000 f. in order to commence a change of weapon and continue the defensive works.

The Lizard and Bramble, sister ships to the Rattler, are building at the works of Messrs. Harland and Wolff at Belfast, and will be shortly ready for delivery to the Government. The Admiralty propose to further increase the Navy with this class of vessel by laying down several in the Government yards in the course of the present year.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended January 2, amounted, on 15,386¾ miles, to 1,053,667*l*., and for the corresponding period of 1886, on 15,246 miles, to 1,073,698*l*., an increase of 140¾ miles, or 0.9 per cent., and a decrease of 20,031*l*., or 1.8 per cent.

The twelve 80-ton guns under construction at the Royal gun factories in the Royal Arsenal, Woolwich, for the defence of Victoria, British Columbia, are expected to be finished in April next, when they will be conveyed to their destination by the Canadian Pacific Railway, together with a large quantity of war material.

Last week, at a special meeting of the Liverpool City Council, the honorary freedom of the city was conferred upon Major-General Sir Andrew Clarke, Inspector-General of Fortifications, in recognition of his eminent services to the city in connection with testing the stability of the Vyrnwy Dam.

The question of the protection of the foreshore at Brighton has been again discussed at great length at the meeting of the Town Council, upon a proposal of the Works Committee to expend 12,000*l*. in the construction of concrete groynes. The recommendation of the Works Committee was finally agreed to.

The torpedo cruiser Fearless, not having developed her contract power of 3200 horses under forced draught at the previous trial at Portsmouth, went out again last week for a six hours' continuous run. Soon after the observations had begun, a bracket which supports the stays of the boiler gave way, and the trial was brought to a premature conclusion.

In order to accelerate the work of providing the torpedo tubes and gear for the forty new torpedo boats, it has been greatly distributed. Of the twenty built by Thornycroft, five sets are furnished by the contractors, five by White, and ten by Rennie; while of the twenty built by Yarrow, five sets are provided by the contractors, five by Bellis and Co., and ten by Maudslay.

Messrs. Cory, Yeo, and Co., patent fuel manufacturers and colliery owners, of Swansea, have expressed their willingness to give all the steam coal or patent fuel, as required, to any Government vessel or vessels stationed in Swansea Bay for the purpose of saving life and property for the remainder of the winter, in accordance with the suggestion recently made by Mr. R. Capper, of Swansea.

The *Times* says, the Scout, torpedo cruiser, which left Portsmouth about a month ago for the purpose of relieving the Cygnet on the Mediterranean station, had a miserable passage out. Her behaviour in a rough sea was not satisfactory. It was twice found necessary to batten her down in consequence of the water which poured in upon her—once before arriving at Lisbon and a second time between Gibraltar and Malta.

The Town Council of the new municipality of West Ham (which adjoins the eastern boundary of the metropolis), have appointed Mr. Louis Angell, M. Inst. C.E., to the office of borough engineer and surveyor at a salary of 1200*l*. per annum, with privilege of consulting practice, arbitrations, and evidence. Mr. Angell held a similar position under the West Ham Local Board during the last twenty years.

The large fort which is in course of erection at Borstal, near Rochester, will be armed with the heaviest guns, and will form one of a chain of four decided upon some years ago for the defence of Chatham and the high road to London. Two of the other forts—one between Rochester and Maidstone, and the other between Chatham and Sittingbourne—are now in course of construction. The work is being carried out by convicts.

The evening lectures on Science of Construction and American Survey Practice, delivered by Mr. Gribble at Exeter Hall, are to be renewed on the 20th inst. Mr. Gribble brings to bear upon his subjects the practical experience of work on both sides of the Atlantic, and we are led to believe that a very rapidly increasing attendance has much encouraged the committee of Exeter Hall to continue them at their present very moderate entrance fee.

A scheme has been devised by the military authorities, and sanctioned by the Commander-in-Chief, for the formation of a new regular corps for the same purposes as are provided for by the German railway battalions. It is to possess all the plant requisite for laying and maintaining about 60 miles of railway, and the appliances for restoring damaged railways, rolling stock being kept in store ready for issue. It is probable that the head-quarters of the corps will be at Crewe and the men be recruited mainly from the railway works there.

On Saturday orders were given at the War Office for another committee on small arms to be formed, the president being Sir Evelyn Wood. This committee is specially charged with the examination of the repeating rifles which have recently been submitted to the War Department, and will be quite independent of the previous committee over which Major-Gen. Philip Smith presides, and which has been of late more particularly engaged in considering the reports on and suggested improvements in the Enfield-Martini.

The contract for the supply of bar iron to the various dockyards of H.M. Navy has again been taken by the New British Iron Company, of the Corngreaves Iron and Steel Works, South Staffordshire. It is interesting to note that the old iron-making district of South Staffordshire, the quality of whose products has tended so much to advance the character of English iron abroad as well as at home, is prepared to compete with younger localities, and where high quality enters into the competition to carry off the prize.

The new composite gun-vessels Rattler and Wasp, which have been built by Sir W. Armstrong and Co., have been delivered at Sheerness. They are the first of a newly-designed class of gun-vessels to take the place of the obsolete Elk and Ready type. They are of 670 tons displacement, and are fitted with engines of 1000 horse-power. Their armament will consist of six 5 in. steel long-range breechloading guns mounted on sponson ports, together with six Gardner and Nordenfelt machine guns. The vital parts are protected by steel deck and shot-proof gratings.

The first annual meeting of the shareholders of Messrs. Boyle and Co., Limited, was held on Tuesday the 11th inst. at Cannon-street Hotel, when a dividend at the rate of 12 per cent. per annum, on the ordinary shares, was declared. The managing director, Mr. Robert Boyle, stated that, taking the general depression in trade into consideration the business done by the company during the past year might be considered as very satisfactory, and that the prospects of the company at the present time were exceptionally bright; the business done during the first three months of this the second year of the company which have already elapsed being in excess of that done during any corresponding three months since the foundation of the business. The election of directors and auditors brought the proceedings to a close.

When the credit for the new Austria-Hungarian repeating rifles was moved for, it was agreed that the rifles for the Hungarian contingent should be manufactured in Hungary, on condition that the Hungarian rifles should be as good as those manufactured at the Werndl factory of Steyer, in Upper Austria. There is no Hungarian factory, however, which could compete with that of Steyer, where 5000 men are employed. It is now proposed to establish an arms factory of the first order in Hungary, and the assistance of foreign capitalists will doubtless soon be invoked for this scheme, which includes a plan for hiring skilled workmen from abroad. It is understood that the Hungarian Government will give its aid to the project by providing buildings and grounds for the factory rent free.

The Board of Trade returns for December, 1886, show that the imports amounted to 31,011,000*l*., an increase of about ¼ per cent., and the exports to 17,054,000*l*., a diminution of about 1 per cent. In the returns the chief feature is the great increase in the quantity of iron and steel exported, the total being 266,000 tons, against 218,000 tons in December, 1885. A large part of the increase is due to the large shipments of unwrought steel to the United States. The amount of pig iron exported to that destination is a trifle less than in 1885, while the increase in bars and other classes of iron is small. Hardware and cutlery show a moderate decrease in value, in spite of a trifling increase in the shipments to America, and machinery and millwork show an increase, which is chiefly due to a large export of steam engines to Russia.

A sulphur sal-ammoniac battery has been invented by Mr. Sydney F. Walker. It is exactly similar to the Leclanché, except that in place of the oxide of manganese used as a depolariser, pure sulphur, in pieces the size of a pea or small bean, is used. Its electromotive force is a trifle below that of the porous cell of Leclanché, while its resistance is considerably less. The internal resistance and life of the cell can be varied within large limits by altering the proportions of sulphur and carbon employed. More sulphur gives a longer life for a given work, and higher resistance, and *vice versâ*. In the working of the battery sulphuretted hydrogen (H_2S) is formed, but does not come away unless the battery is worked very hard, or is nearly worked out. When quite worked out a yellow substance, some compound of sulphur, exudes through the ventilating hole at the top of the cell, so that there can be no mistake as to which cell requires attention.

The Admiralty have inquired of the authorities at Devonport Dockyard what ships could immediately be got ready for sea in the event of an emergency, and the following list has been sent them: The Black Prince, 28, ironclad, of 9210 tons and 5770 horse-power, which could be got ready to hoist the pennant in three weeks; the Landrail, 4, gun and torpedo vessel, of 785 tons and 1200 horse-power; the Espiègle, 10, composite sloop, of 1130 tons, and 1140 horse-power; the Acorn, 8, composite sloop, of 970 tons, and 1380 horse-power; and the Amphion, 10, second-class steel steam cruiser, of 3750 tons, and 5650 horse-power, all of which could be made ready in a little over a week. The Hecate, 4, turret ship, of 3480 tons, and 1750 horse-power, could be immediately detached for coast defence, and the Mutine, 6, composite sloop, of 1130 tons, and 1120 horse-power, which vessel has undergone repairs well-nigh amounting to rebuilding, could be prepared for manning much earlier than March next.

STEAM SHIPBUILDING IN NORWAY.—The building of steamers in Norway never amounts to anything of importance, but in 1886 it has not even been able to reach the modest figures of previous years. The figures for the last five years are as under:

In 1882 built	18	steamers	with	3042	registered	tons.	
„ 1883	„	22	„	„	5189	„	„
„ 1884	„	30	„	„	8400	„	„
„ 1885	„	26	„	„	5583	„	„
„ 1886	„	15	„	„	1600	„	„

PROPOSED HYDRAULIC POWER WORKS AT NIAGARA FALLS.

Fig. 1.

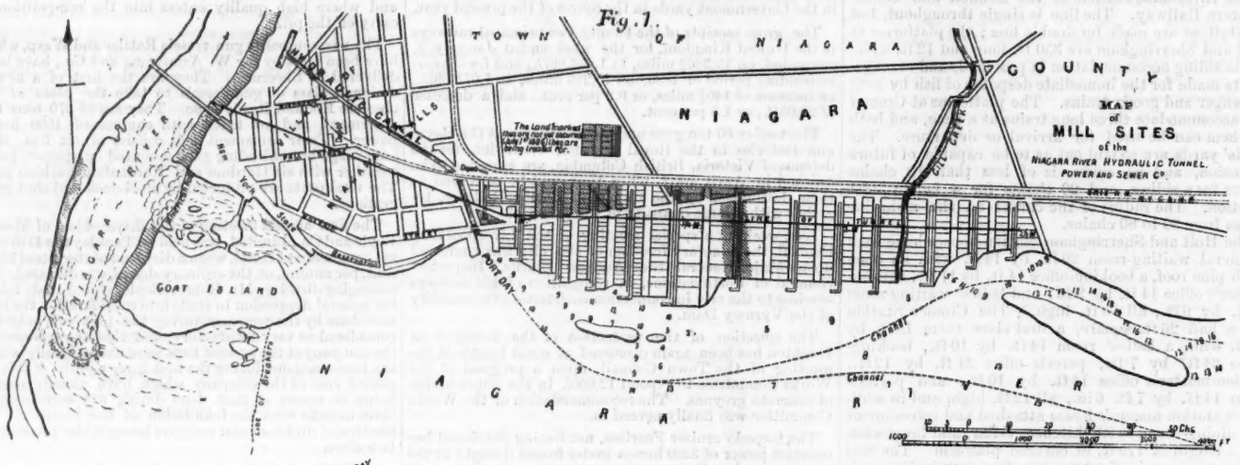


Fig. 3.

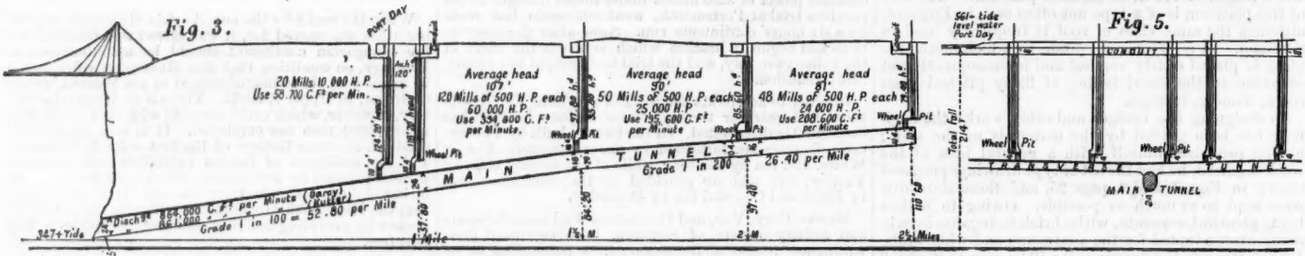
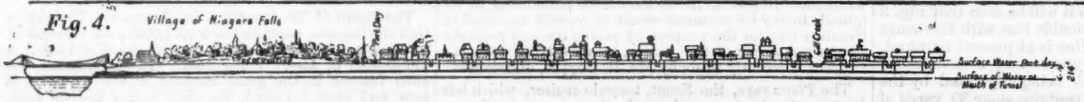

20 Mills 10 000 H.P. Use 58.700 C.Ft per Min.
Average head 107'
120 Mills of 500 H.P. each 60,000 H.P. Use 334,800 C.Ft per Minute.
Average head 90'
50 Mills of 500 H.P. each 25,000 H.P. Use 155,600 C.Ft per Minute
Average head 81'
48 Mills of 500 H.P. each 24,000 H.P. Use 208,600 C.Ft per Minute
MAIN TUNNEL
Grade 1 in 200
26.40 per Mile
Discharge 464,000 C.Ft per Minute (Barge) (Rutter)
Grade 1 in 100 = 52.80 per Mile
1 Mile
2 Miles

Fig. 5.

Fig. 4.



OUR readers will have noticed in some of the daily papers the announcement of a proposed enormous undertaking designed to render a part of the water, now running to waste over the Niagara Falls, useful in the production of power. Although the power which it is designed to supply amounts to the great total of 200,000 horse-power, yet this represents such a small fraction of the energy developed by the descent of the river, that less than one per cent. of the water which now dashes itself over the fall, will be diverted into a more useful channel. Thus the volume of the river will not be sensibly decreased, and while trade and commerce will be benefitted there will be no impairment of the beauty and grandeur of the fall.

The proposed scheme is illustrated by the engravings above, and is very simple in its main features. On the south bank of the river there has been secured a large plot of land, which has been parcelled out into building sites for mills and manufactories. Under this piece of land, and at a distance of 400 ft. from the stream, a tunnel is to be cut at a depth of about 100 ft. from the surface, and into this tunnel there is to be poured all the tail waters from the turbines of the mills. The tunnel will gradually increase in section until it attains 30 ft. in diameter at Port Day, which is the limit of the land available for building. From this point the tunnel will be cut to strike the river below the falls, where it will discharge its contents. The water is drawn from the river by surface conduits, at right angles to the bank and also to the tunnel, and as the various turbines cannot be situated above the main tunnel, a cross-tunnel will be driven (Fig. 5) under the lines of the conduits to receive the tail water of each group of mills and deliver them to the tunnel.

The details of the scheme are shown on the engravings. The head available at the end of the tunnel is 79 ft., and this gradually increases until it becomes 124 ft. at Port Day. The discharging capacity of the tunnel is estimated at 861,000 cubic feet per minute. The work will require two years to complete, at an estimated cost of 800,000*l.* to 1,600,000*l.*, the McBeen Tunnel Company being the contractors.

Between Port Day and the upper end of the tunnel the town plat is to be laid out, with streets running at right angles to the main tunnel. Every other one of these streets will be made of such a width as will allow of a raceway or conduit for the passage of the water from the river to supply the factories with power, and to allow the usual traffic by teams, and also with proper sidewalks leading to the factories. The intervening streets, at the rear of the buildings, will be of sufficient width to accommodate railroad tracks. Permanent embankments will be made out into the river, and finished off at the outer end with crib work, running up and down the river in such a way as to form wharves for vessels and protect the different raceways from floating ice.

AN ELECTRIC BATON.

FREQUENTERS of the Opera must have often been struck by the regularity with which the chorus and orchestra at the wings follow the time beaten by the leader of the orchestra. It is seldom that the arm of the conductor is before or behind the concealed voices or instruments. This result has hitherto been obtained by the leaders of the choruses keeping their eyes on the conductor, but it was often difficult to do this, particularly when the stage was entirely filled with the scenery. The musician who beats the time in the wings was then obliged to steal a glance at the front of the stage through a crack or hole and manage as best he might.

Recently this method has been superseded by an electric metronome invented by M. Carpentier, the successor of M. Ruhmkorff. This is fixed on the desk of the leader of the orchestra in the wings, and is connected with the desk of the conductor by two wires. We give three illustrations of the apparatus. Fig. 1 represents the desk of the conductor, or *chef d'orchestre*, and shows the key operated by his foot, together with a repeating metronome which lies before him. Fig. 2 shows the instrument hung in the wings, while Fig. 3 gives a back view of the same, and exposes the mechanism. The action of the instrument, as far as regards the musician, depends upon a curious optical illusion. They see on the face of a black board (Fig. 2), two lines radiating from a centre; one line is white, while the other is black, and scarcely visible. Each of these lines marks the position of a square rod let into a slot cut in the board which forms the face of the instrument. The rods can be rotated a quarter of a revolution on their axes, and show alternately two sides or faces, of which one is white and the other black. The two rods always show opposite colours, and move simultaneously with the greatest rapidity, the white disappearing from one slot and reappearing in the other in a way which gives the impression that it has swept over the section between them. The illusion is absolute and complete, even when the artifice is understood.

The mechanism is shown in Fig. 3. The two rods, G and H, are centred at their ends, and the inner extremity of each carries a little pulley on which is wound a cord. This cord is connected to the armature of the electro-magnet, while at its other end it is drawn taut by a spring which effects the back stroke. Ordinarily the springs maintain the rods in one position (Fig. 2), and the passage of the current puts them into the opposite position. The circuit is closed by the pedal key A (Fig. 1), worked by the foot of the conductor. When the conductor presses it the phantom baton falls, and when he raises his foot it rises. These motions are repeated under the eyes of the conductor by the small metronome D, connected to the wire C. The whole apparatus is installed in the Paris Opera House, where, as we learn from our contemporary, *L'Illustration*, to whom we are indebted for these facts, it works most successfully.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, December 31.

BROKERS in New York and Philadelphia have instructions from their principals in the interior to close for large quantities of Bessemer pig, steel rail blooms, slabs and billets during January, or at once if stocks can be had at certain prices. The agents here have been cabling abroad doing their best to carry out instructions received, but the business of the past week has not been very heavy. Quotations are for billets 30 dols. to 30.50 dols. and nail slabs 30.50 dols., sales 4000 tons. The inquiries in hand for foreign material at this time may be estimated variously at from 50,000 to 100,000 tons. The only reason why large orders are not placed is the fact that blooms have advanced from 24 dols. to 29 dols. to 30 dols., and slabs and billets correspondingly. Heavy orders are in the market for old rails, and 24.50 dols. is the present bottom price for tees and 25.50 dols. for double heads. A New York firm has just sold 10,000 tons on private terms. There are inquiries here for no less than 50,000 tons of old rails, and brokers in New York and elsewhere are buying and crowding up the market in consequence. The American iron trade is very strong, and large orders are being placed for crude iron. One company, the largest in the country, has booked orders for about 275,000 tons already. It is nearly all the iron that company can make during 1887; 20,000 tons of Bessemer pig are wanted to-day at 20 dols. The lowest price at which that material is offered is 20.50 dols. Several thousand tons of spiegeleisen are wanted at 28 dols., but 25 to 50 cents more is paid. A great deal of foreign material, however, must be purchased at the best prices which can be had. Large orders for structural iron will be placed during the next sixty days and a further advance of about 2 dols. per ton is predicted. Imports of steel and iron rods since January 1 foot up 103,231 tons; of spiegeleisen, 102,895 tons at New York; pig iron, 94,147 tons; tin plate, 2,009,726 boxes; steel blooms and billets, 41,599 tons; old rails, 27,954 tons; crop ends, 16,810 tons; Straits tin, 9336 tons; Australian, 1200 tons; English tin, 185 tons.

CARPENTIER'S ELECTRIC BATON.

(*For Description, see opposite Page.*)

FIG. 1.

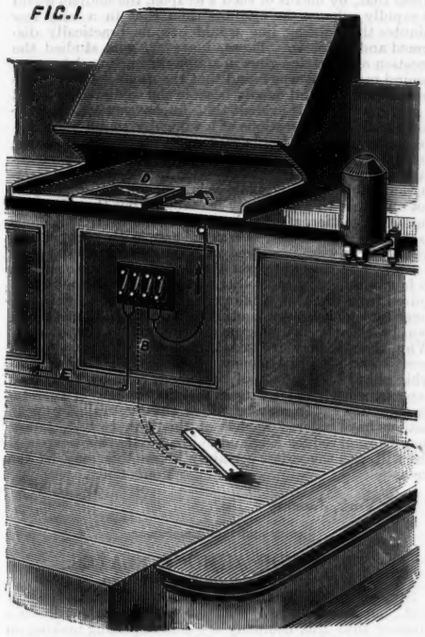
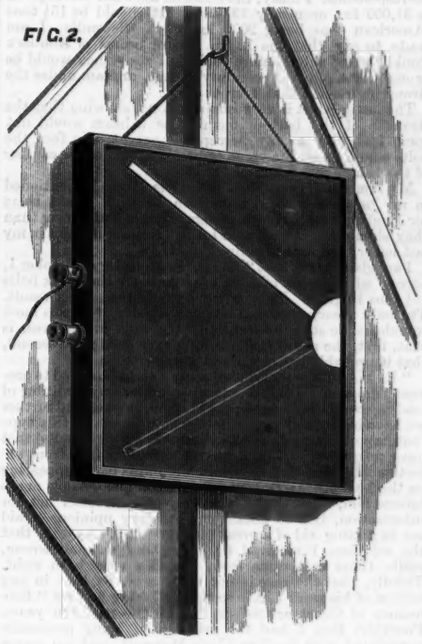


FIG. 2.



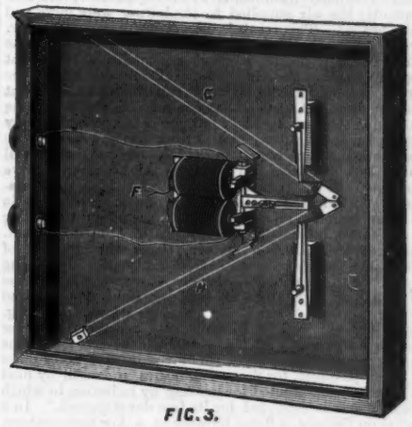


FIG. 3.

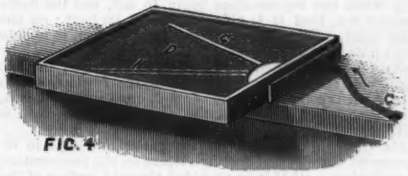
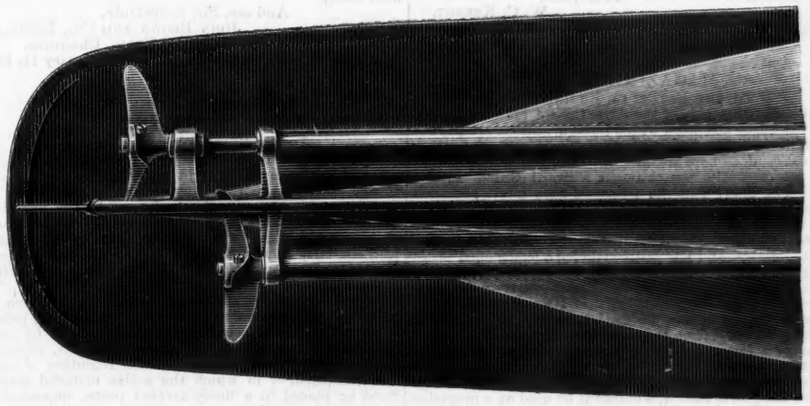


FIG. 4.

MACLAINE'S ARRANGEMENT OF TWIN SCREWS.



ABOVE we illustrate a device for placing twin screws, that has recently been introduced by Mr. Alexander MacLaine, of Belfast. Our engraving is taken from a photograph of a model made to illustrate the principle. The model in question is supposed to represent a vessel 500 ft. long, 50 ft. wide, and with a load draught of 26 ft. The screws are each three-bladed and 19 ft. in diameter. They are not placed in the same athwartship line, one being carried 11 ft. further aft than the other, there being two screw appertures in the deadwood each 6 ft. across and 16 ft. high. The tips of the blades are thus allowed to overlap 5 ft. The advantages claimed for this arrangement are that the screws can be brought nearer the centre line of the vessel without decreasing their diameter, and a shorter length of outside stern tube is therefore required. The objectionable supporting brackets are also to a great extent done away with. The propellers are in addition more snugly tucked up under the vessel's quarters, a great advantage in docking and going alongside quays. It is said that the propellers are sufficiently distant not to interfere with each other in working.

SILICON IN PIG IRON.

TO THE EDITOR OF ENGINEERING.

SIR,—On returning to Birmingham after the vacation my attention has been called to your article on silicon in foundry iron by a correspondent who writes to me as follows:

"In ENGINEERING of December 24 you would no doubt see the article on 'Silicon in Foundry Pig Iron.' The writer gives us the play with 'Hamlet' left out. I was sorry to see no mention of your name in connection with the matter, as the generous recognition of one's labours in the inception of a most important work is the very least you could look for. However useful the work of Mr. Wood, M. Gautier, and others has been, without the base with which you supplied them, their superstructure could not have been reared."

The writer is an ironfounder in the west of Scotland who has carefully watched the matter for some time, and who wrote to inform me of the successful application of silicious pig iron in his foundry.

It may be well to mention that M. Gautier frankly acknowledges to have adopted the process from Mr. Wood's paper at the Iron and Steel Institute (Glasgow, 1885). This he has stated both in conversation, in private letters, and in print. Now Mr. Wood's paper on this subject commences as follows: "In a paper read before the Chemical Society in the spring of this year, Mr. T. Turner gives an interesting account of some experiments carried out by him, by mixing pig containing 9.8 per cent. of silicon with what he calls pure cast iron, and he endeavours to show that by increasing the silicon from 0 up to 2 per cent., the strength of the iron was increased from 10.14 tons per square inch up to 15.75 tons, but that with any addition beyond 2½ per cent. the strength gradually decreased again. Results such as this seem startling, and if they could be obtained in practice when remelting Cleveland iron, would be of immense importance, being equal to increasing the strength of the castings over 50 per cent. . . . Although I have not been able to approach the wonderful results mentioned by Mr. Turner, still I may say with satisfaction that by care in selecting the iron before going into the cupola I have been able to raise the strength of soft iron to about 29 cwts."

Now, Sir, I would not for a moment detract from the value of the skill and practical application of my friend Mr. Wood, to whom the present practical outcome is so largely due; nor from the labours of M. Gautier, through whom the use of silicious iron has been so largely adopted on the Continent. But I would venture to point out that my experiments were commenced in 1883, my first paper on this subject being published in the spring of 1884, when I received a grant from the Chemical Society towards the expenses of the research already begun. And I have shown that Mr. Wood, in the paper published September, 1885, was attempting to imitate in practice on the large scale what I had already done in crucibles, and have since done in the cupola.

And, with the correspondent previously alluded to, I believe that when a scientific man works with no pecuniary object in view, but for the love of his subject and the hope of being useful, that if others reap the monetary advantages of his observations, he is at least entitled to a generous recognition of his labours.

I am, yours truly,

THOMAS TURNER.

Mason College, Birmingham, January 11, 1887.

DISSOCIATION IN THE STEEL FURNACE.

TO THE EDITOR OF ENGINEERING.

SIR,—I beg to say a few words in answer to Mr. Frederick Siemens' criticism which appeared in your issue of December 31 on my article on the above subject which appeared in your issue of December 10.

In the first place the difference in the temperature of dissociation arrived at by Deville and by Bunsen, may be explained by supposing Deville's temperature of 1000 deg. Cent. to be that at which steam commences to decompose, and Bunsen's temperature of 2400 deg. Cent. to that of total decomposition. This is borne out by the recent experiments of Mr. Dugald Clerk on explosions of gases in closed vessels, which were described in ENGINEERING; they will also be found together with other matter bearing on this subject in his book on "Gas Engines." In a gas engine cylinder a temperature of about 1600 deg. Cent. is usually attained on explosion, when only one-half of the gases are able to combine, owing to dissociation, and I have no doubt that at Bunsen's temperature of 2400 deg. Cent. no combustion or combination would be possible, as the heat would be sufficient to hold the whole volume in a state of dissociation. With regard to my statement that carbonic acid began to decompose at a temperature below 1000 deg. Cent., Bunsen's temperature of 3000 deg. Cent. may be correct, there is no reason why because carbonic acid commences to decompose at a lower temperature than steam, it should not require a higher temperature than steam for complete decomposition. I distinctly gave the temperatures as those at which decomposition commenced, and not at which it was complete.

In speaking of the effect that the heat of a furnace has on a flame, my remarks were not applied to the radiation furnace, but to furnaces having their ports so built as to

throw the flame on to the furnace bed; in the radiation furnace, and under the conditions Mr. Siemens describes, I can well understand the results being opposed to my statements. Mr. Siemens says, "In this stove the flame, when the gas was first lighted, was very long, but its length gradually diminished as the regenerator, and consequently the air supplied to the burner were more and more heated. This result is diametrically opposed to Mr. Crowe's statement." In Mr. Siemens' stove it is the flame which becomes hotter, whereas my conditions were that the furnace becomes hotter, the flame remaining the same. It would hardly be fair to experiment on the effect that cold and hot surfaces have on a flame, if a cold flame be used in the one case and a hot one in the other. In my article I pointed out my idea of the cause of a flame being lengthened when burnt in a hot furnace, and will now point out why the flame in Mr. Siemens' stove shortened as it became hotter. At high temperatures substances radiate heat in much greater ratio to their increase in temperature. According to Dulong a substance having a temperature of 1500 deg. Cent. will lose by radiation sixteen times the amount of the same substance at 1000 deg. Cent. Supposing that when the gas in Mr. Siemens' stove was first lit the flame had a temperature of 1000 deg. Cent. and radiated one unit of heat, when its temperature attained 1500 deg. Cent. it would radiate 16 units, and become shorter for reasons stated in my article. Mr. Siemens says: "Flame is only lengthened by heat when combustion takes place in small passages, for flame diminishes in length by heat in furnaces constructed for heating by radiation in which ample space is provided for its free development." In a radiation furnace, a flame burning at a low temperature, will naturally be long, because such a flame has little radiating power, and loses very little of its heat; it is only when the regenerators begin to act, and the flame becomes hot, that it is able to give off its heat; on the other hand, a flame touching the furnace bed, is able to give up its heat at a low temperature, as it does so both by contact and radiation, and consequently burns short to begin with; I may say that some of the furnaces which Mr. Siemens concludes were of small cross-sectional area, have 34 square feet area at the centre when the bath is full.

Mr. Clerk in his book on the gas engine says in reference to the effect of cooling surface on the temperature of explosions: "If it be true that the cold surface of the vessel is the limiting cause, then the maximum pressure produced in exploding the same gaseous mixture, in vessels of different capacity, will greatly vary. When the vessel is small and the surface therefore relatively large, more heat should be abstracted and lower pressure should be produced. This is not the case. The maximum temperature produced by an explosion is almost independent of the capacity of the vessel." This hardly agrees with Mr. Siemens' statement that the difference in the shape of the vessels employed by Deville and Bunsen accounts for so much difference in their results as that between 1000 deg. Cent. and 2400 deg. Cent. amounts to.

With regard to the intensity of the various parts of a flame, that entirely depends on the kind of flame and the conditions under which it burns; the gas and air may be mixed together as quickly as possible either by a blowpipe or by causing them to strike the furnace bottom, or they may be mixed slowly by allowing them to quietly float across the furnace in parallel layers, as I suppose they do in the radiation furnace. It is well known how the intensity of a flame is increased by a thorough and rapid mixing up of the burning gases, as is well illustrated by Mr. Fletcher's blowpipes; the more perfectly gases can be mixed before or as soon after ignition as possible, the more intense is the flame, because whatever portion of the gases burn before the whole is mixed combines and lowers the temperature of dissociation, and consequently the maximum temperature of the flame. In some furnaces the air is made to dive down into and at nearly right angles to the gas by an arrangement called the hackney port. I believe that this arrangement is very effective in increasing the temperature of the flame. In Mr. Siemens' furnace the air and gas will take a long time to mix, and will be burning a long time before thorough mixing occurs; such being the case the hottest part of the flame may possibly be quite at the tail end. I cannot help thinking that this arrangement must reduce the temperature which the flame might otherwise attain.

I quite agree with Mr. Siemens in saying that the ports are the hottest and most effective parts of the regenerators; I even think they are the hottest parts of the furnaces: they are the only parts the flame touches, excepting the bath, and yet they are the only parts of a furnace which are not ventilated; the roof is only 9 in. thick, the bridges and bottom are ventilated; if the ports were ventilated they would form a very small fraction of the total ventilated surface, and when it becomes a matter of choosing between frequent repairs and stoppages, and a very small increase in coal consumption, I really think it is in the interests of economy to choose the latter.

It would be interesting to know what chemical action can take place between flame and silica; a flame is hotter than its products of combustion, which is a very good reason for its melting silica when its products do not; heat also is a mechanical motion, and melting by heat may be considered as a mechanical action.

I do not doubt that Mr. Siemens is able to lengthen a flame by turning on more gas and air. I do not suppose any one would for a moment dispute that; I am also perfectly satisfied that the action of the flame in Mr. Siemens' stove is exactly as he describes it, and only wish to point out the reasons why the action of flame in his furnace is as he supposes diametrically opposed to my statements.

I remain, Sir, yours truly,

EDWARD CROWE.

Grove Hill, Mid Ilesbrough on-Tees, January 8, 1887.

A BRIDGE QUESTION.

TO THE EDITOR OF ENGINEERING.

SIR,—In my letter appearing in your issue of September 24 last, there are two errors for which I do not think I am responsible. Firstly, the stress on the weak bolt is given as 31,000 lb., or nearly 13½ tons. It should be 15½ tons (American tons being 2000 lb. only). Secondly, I am made to say that the 12 in. square beams of ironbark would deflect 6 in. before their full resistance would be brought into play. I certainly meant, and am under the strong impression that I wrote 6 *feet*.

The latter point is very important as showing that the strength of the bottom member as a beam would not come into play to any perceptible extent. In fact the bolts would be on the verge of breaking before the camber of the bridge was taken out of it.

My American friend has taken the "tons" mentioned in my first letter to be American tons. I meant them for English tons. Hence his figures are a little lower than they should be. I apologise for not mentioning this in my last letter, and so misleading "R. H."

I am glad to find that "R. H.," in his letter of October 1, agrees with me in making the stress on the weak bolts 15½ tons English. This is undoubtedly the correct result. The only theory on which we can account for this most reprehensible structure escaping the fate it deserves, is that, first, the metal in the bolts is very good; and second, that it probably has never had a crowd upon it.

"R. H." thinks that queen posts should be added to prevent vibration. I fail to see why, under no condition of loading can the bolts be exposed to compression, and further we have in Australia multitudes of bridges of this type (but happily in most cases with much stronger bolts) that have no queen posts and are yet firm and free from objectionable vibration. "F. S. C." in his letter appearing on the 1st October, is very severe upon me. Allow me to inform him, first, that I wrote my original letter not for information, but to obtain confirmatory opinions to aid me in getting rid of a great public danger. Second, that the solutions I received from England were all wrong, while those that came from America were both right. Thirdly, that the case is not dealt with by Bow in any edition of his work I have seen, and I have had his "Economics of Construction" in use for the past ten years. Fourthly, that I had the privilege of being personally acquainted with the late Clerk Maxwell, and am aware he was not an American; and finally, that an old proverb about a prophet not being without honour except in his own country, seems to have been illustrated in the present case, for certainly the American correspondents know their Bow and Maxwell, while the others, at any rate at first, did not.

Yours, &c.,

W. C. KERNOT.

Melbourne, December 1, 1886.

MAGAZINE GUNS.

TO THE EDITOR OF ENGINEERING.

SIR,—On this side of the Atlantic we note with interest the eager attention which foreign nations are paying to military weapons, and especially to magazine guns, and many of us here are affected in the same way. One gun has recently been brought forward which, in the opinion of many experts, possesses such merit and such simplicity of mechanism as to fully justify the expectation that it will prove one of the coming magazine rifles.

This gun has been invented and constructed in the United States, and has just concluded a lengthened series of trials, during which no hitch or accident of any sort has occurred, the experts who have had it under consideration pronouncing strongly and unanimously in its favour. The gun can be fired ten times in succession without taking it from the shoulder, and it is distinguished from other forms of magazine guns in having a magazine built into the gun itself in which the cartridges are superposed horizontally the one on the other, and through which the gun is loaded, whether it be used as a magazine gun or as a single-loader.

The advantages of this arrangement are that the magazine may be filled at all times; that it may be kept full, half full, or empty; that the soldier can at all times tell at a glance the state of his magazine; and, lastly, that he can always replace a fired cartridge by a new one *whilst his gun is loaded*, instead of being obliged to do so when his gun is empty, as in other systems. Those who, like myself, have seen men in action fumbling vainly for cartridges with empty guns, and the enemy close upon them, appreciate this feature as it deserves.

Furthermore, the gun is a wedge gun, as contradistinguished from either the bolt system or the falling block (Martini-Spencer, Peabody, &c.), and in combination with this wedge are: 1, a starter which forces the cartridge from the chamber with a power of about 10:1; and 2, an extractor which withdraws the empty shell and ejects it from the gun, throwing it forward instead of into the firer's face or over his head, as is so often the case.

The new cartridge is also brought into its place and carried into the chamber mechanically; all the motions of the action are mechanically positive, and are effected by the simplest means. The whole of the work of the gun is done by a slide running on a pair of steel rails, supported by, but not attached to, the wood, so that the expansion and contraction of the latter by heat, moisture, &c., in noways affect its freedom of motion, which is absolute at all times. The gun is a three-motion gun.

1. The slide being brought back, drops the wedge, starts, extracts, and ejects the empty shell, sets the hammer to full cock, and locks the trigger, at the same time bringing up a new cartridge into the axial line of the gun.

2. The slide being carried forward, forces the new cartridge into the chamber, raises the block behind it, locks the latter in place, releases the trigger, and finally secures itself in place.

3. The trigger is pulled to fire the gun.

So rapidly are these motions performed that the gun has repeatedly been fired ten times in five seconds.

Here, as with you, the old time-worn objection has been raised that, by means of such a weapon, the soldiers would so rapidly exhaust their ammunition that in a very few minutes the fighting line would become practically disarmed and helpless. Those, however, who studied the question of magazine guns in action during our late war, remind me that it was found that the quicker the gun the more deliberate and deadly became the soldier's fire, and it appears to be self-evident that in case you can simplify and shorten the operations of loading by sound mechanical contrivances, as has been done in the present instance, the time thus saved may be used rather for taking a careful aim and increasing the effect of the fire than for wasting ammunition, and many able officers are of opinion, not only that this can easily be taught, but that, furthermore, the soldier, after a short use of the arm, will come to it of his own accord, as was the case with such of our regiments as were furnished with the Spencer repeater.

I may add that the parts of this new gun are so simple, so few in number, and so little strained by the effort required from them, that the gun is not liable to derangement by bad usage or continued firing; and, moreover, can be cheaply manufactured and put on the market. Why, then, it may be asked, does the English Government spend time and money at Enfield in testing guns which have been repeatedly rejected, even by their own experts, when here is a weapon certainly worthy of a careful examination? It may be added that several European nations have ordered models of this gun to test, but it may be reserved for England to inaugurate this weapon if she will, and the writer certainly hopes this may be the case.

Yours truly,

W. H. W.

New York, January 3, 1887.

STEEL FOR ARMOUR PLATES.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to your issues of the 31st ult. and 7th inst., our attention has been drawn to your remarks on a rumour that this company are contemplating making an arrangement with Messrs. Schneider, of Creusôt, for adopting their method of making steel armour plates. We beg to inform you that there is not the slightest foundation for this rumour.

We shall be obliged if you will insert this letter in your next issue,

And are, Sir, yours truly,

JOHN BROWN AND CO., Limited.

JOHN D. ELLIS, Chairman.

Atlas Steel and Iron Works, Sheffield, January 11, 1887.

SECONDARY BATTERIES.

TO THE EDITOR OF ENGINEERING.

SIR,—In the last issue of your journal I find notice given of a storage cell brought out by the Union Electrical Power and Storage Company, whose plates, from the description given, appear to consist, as to the negatives, of an agglomerated mass of peroxide of lead fixed in frames of celluloid, and as to the positives, of spongy metallic lead similarly framed, but with the addition of strips of lead, electrical contact being made by means of a strip of platinum.

May I ask you to publish for general information the following epitomised extracts from one of my early patents —No. 5631 of 1881, being the third taken out by me in that year, in which I describe plates, supports, retainers, or frames of any suitable form for the retention of active material (upon or in which the active material may be fixed or placed in a finely-divided pasty, deposited, or compressed condition), constructed of materials not readily subjected to the destructive influence of oxidation or other destructive action, and specifying, amongst other materials, "cellulose, either alone or in combination with platinum, such combination forming a terminal"? My claim runs as follows:

"The construction of terminal plates, supports, retainers, or frames employed in secondary batteries of a material not readily subjected to the destructive influence of oxidation in the manner and for the purpose herein described."

This patent is (as are also the whole twelve taken out by me at various times in connection with secondary batteries) the property of "*The* Electrical Power Storage Company, Limited," who will doubtless at once take the necessary steps to prevent their "Union" namesakes infringing their rights.

I am, Sir, your obedient servant,

JOHN S. SELLON.

January 12, 1887.

TOOTHED GEAR.

TO THE EDITOR OF ENGINEERING.

SIR,—I venture to take exception to the conclusions arrived at by your correspondent Mr. Hartland with reference to pitch of wheels, at the risk of being thought stupid, or having mixed ideas. I do not think this question can be settled in such an off-hand fashion.

The question of "Discipulus" is an important one, for it has puzzled large numbers of practical men and not a few mathematicians; some weight should be given to the observations of men whose whole lives have been engaged in wheelwork. It will be seen that the calculations of Templeton and Molesworth do not agree; take the illus-

tration already given by previous correspondent, to find the diameter of pinion 8 teeth 3 in. pitch.

Templeton says, $\frac{8 \times 3}{3.1416} = 7.6394$ diameter.

Molesworth's C $2.6131 \times 3 = 7.8393$ diameter.

The one representing the arc pitch, the other the chord pitch, and cannot therefore be based on the same calculation as your correspondent asserts. If one calculation was used instead of the other for the construction of a pair of wheels with rigid centres, a fatal error would be made.

There are many who believe that Molesworth's constants should be taken, and that the chord pitch is the correct one, for the following reason, if the pair of wheels 120 teeth 3 in. arc pitch and pinion 8 teeth 3 in. arc pitch be drawn out full size with the wheel tooth in a vertical position, the top or convex part of it swept with the pitch on the pitch circle, also the flanks or concave part of the pinion be swept with the same radius, which produce a natural curve, it will be shown that but one tooth is doing the work, the pinion, therefore, will advance a little before the next tooth comes into contact, which is disastrous when the power transmitted is great. A case in point came under my notice in connection with a pair of wheels for a large steam crane, the pinion having ten teeth and 2½ in. arc pitch with a velocity ratio of 13, the pinion was continually breaking; after investigation it was decided to make the chord pitch of pinion equal to the chord pitch of wheel, moving the brackets of pinion shaft back to suit; this gave very satisfactory results. It has been, and is the practice of many mechanics, that in stepping round the pitch circles of a pair of wheels, the compass opened say to 3 in., shall step round both wheel and pinion; and apparently no evil results follow. I hope, Sir, this question will be fully investigated, thanking you in anticipation of inserting this in your valuable paper.

Yours truly,

January 11, 1887. TOOTHED GEARING.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to Mr. Hartland's letter in your last issue, if the tables in Templeton and Molesworth are based on the rules he gives, why is it that the velocity ratio in the example I gave does not come out correctly, as his rules would evidently give a pair of theoretically accurate wheels? I think the tables must be calculated on the assumption that the pitch is a chord of the pitch circle. I am aware that this assumption would not make any material difference in wheels about the same size, or of small pitch, but in a spurwheel of 120 teeth and a pinion of 8 teeth, 3 in. pitch, the difference *is* material, and if the arc set out from Molesworth, they will be incorrect, as I know from experience.

Perhaps Mr. Hartland can refer me to some tables where the arc pitch is made the basis of calculation.

I remain, yours truly,

DISCIPULUS.

JUBILEE OF RAILWAYS, PARIS, 1887.

TO THE EDITOR OF ENGINEERING.

SIR,—We beg to inform you that a public meeting will be held at the Cannon-street Hotel on Tuesday the 18th instant, at three o'clock, for the purpose of hearing a detailed explanation of the arrangements in contemplation for obtaining the most beneficial results from the above International Exhibition and Congress, and being informed of the official adhesions which have been received from foreign countries.

The chair will be taken by the President of the Institution of Civil Engineers, and the meeting will be attended by representatives of railway companies, chambers of commerce, the City Corporation, and other public bodies.

A delegation from the French Executive Committee, accompanied by members of the Municipal Council of Paris and other Paris delegates, will come over to London in order to attend the meeting.

We trust you will kindly insert this communication in an early issue, and acquaint your readers that admission can be obtained by applying for a letter of invitation at our office as below.

Yours faithfully,

ALF. LOUIS, Commissioner General.

New Broad-street House, London, Jan. 12, 1887.

A VOLTAIC BATTERY PROBLEM.

TO THE EDITOR OF ENGINEERING.

SIR,—Can you oblige me by putting the following question into your correspondence column? Probably the information sought would be appreciated by many of your readers.

When a voltaic cell containing a pair of zinc and copper plates in dilute sulphuric acid is joined in single series to another cell, having the copper plate replaced by one of iron or some other metal and the circuit completed, it appears that equal quantities of zinc should be dissolved in each cell, because the same current passes through both cells in the same time. Other things being equal, the energy of an electric current is proportional to the electromotive force producing it; and when the cells are used in series the electromotive force of the combination is the sum of their separate electromotive forces. It would, therefore, appear that in the combination mentioned, each cell having a different electromotive force, it does a different amount of work in the same time, whereas according to the conservation of energy the work done by each cell should be equal, because the zinc dissolved is equal. What is the true explanation of the apparent difference?

I am, Sir, your obedient servant,

AUGUSTUS A. SADD.

Salford, Manchester, January 7, 1887.

[The energy developed in a cell varies with the amount of zinc consumed; part of this energy appears as electric current and part as heat in the cell, the proportion depending on the electromotive force of the couple.—ED. E.]

TESTING DYNAMOS.

TO THE EDITOR OF ENGINEERING.

SIR,—The following method of testing the efficiency of a dynamo is simple and accurate, and I think new. To illustrate the method in its simplest form, take the case of a series dynamo.

Let the dynamo be run at n revolutions per minute, and with a current C have terminal electromotive force E. Now drive the same machine as a motor and alter the work it is doing and introduce the resistances until the speed and current are the same as before, and let E be the terminal electromotive force. Since the current is the same in the field magnets and in the armature in both cases, the magnetism produced by both must be the same respectively, and the magnetic pull between the armature and field magnets must be the same in both cases, the lead of the brushes being maintained constant in amount. Let this pull be p pounds, then the horse-power in both cases is

$$\frac{p\,n\,\pi\,d}{33{,}000}$$

where d is the diameter of the armature, and this in volt-ampères per second is

$$\frac{p\,n\,\pi\,d}{33.000} \times 746.$$

Call this W.

If x be the efficiency of the machine from the first experiment, we have

$$x = \frac{E\,C}{W} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and from the second experiment

$$x = \frac{W}{E_1\,C} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and substituting the value of W from (1) we get

$$x = \frac{E\,C}{\frac{x}{E_1\,C}}$$

$$\therefore x = \sqrt{\frac{E}{E_1}} \quad . \quad . \quad . \quad . \quad (3)$$

This formula will not apply to a shunt machine, as, when the total current is the same in both experiments, the currents flowing through magnet coils and armature will not be the same respectively.

To determine the efficiency of a shunt machine by this method, let the dynamo, when run at n revolutions per minute, give an external current C with a terminal electromotive force E, and let the current in the armature be C_a and in the magnet coils be C_m.

Now run the machine as a motor, and let a resistance r be introduced into the magnet circuit and adjust r, and the work the motor is doing until the currents in armature and field magnets are C_a and C_m respectively, and the speed is n revolutions per minute as before, and let E_1 be the electromotive force at the terminals of the armature.

It is evident that

$$E = E_1 - C_m v.$$

The magnet pull between the magnets and armature will be the same in both cases, and the mechanical work done in both cases will be the same; call this W in volt ampères per second.

Then form the first experiment if the electrical work produced by the dynamo is

$$E\,C,$$

and this may be written

$$E\,(C_a - C_m)$$

and letting x denote the efficiency we have

$$x = \frac{E\,(C_a - C_m)}{W} \quad . \quad . \quad . \quad (a)$$

and the electrical work absorbed by the motor in the second experiment is

$$E_1\,C_a + E_1\,C_m - C^2_m\,r$$

and this may be written

$$E_1\,C_a + E\,C_m,$$

and we have

$$x = \frac{W}{E_1\,C_a + E\,C_m} \quad . \quad . \quad . \quad (b)$$

and substituting the value of W from (a) we get

$$x = \frac{E\,(C_a - C_m)}{\frac{x}{E_1\,C_a + E\,C_m}}$$

and

$$\therefore x = \sqrt{\frac{E\,(C_a - C_m)}{E_1\,C_a + E\,C_m}} \quad . \quad . \quad (c)$$

It will be seen that this method of testing the efficiency of a dynamo is quite independent of any brake that may be employed.

I am, yours truly,

R. P. FUGE.

LAUNCHES AND TRIAL TRIPS.

ON December 30 there was launched from the yard of the Sunderland Shipbuilding Company, Limited, an iron screw steamer built to the order of the Louth Steam Navigation Company, Limited; her dimensions are 80 ft. by 15 ft. by 7 ft., classed at Lloyd's; the machinery has been supplied by Messrs. Fisher and Co., of Paisley, having cylinders 10 in. and 20 in. by 12 in. stroke, with a working pressure of 90 lb. per square inch. The vessel is specially designed for canal traffic, the whole of the machinery and outfit being fitted on the stocks. Steam was got up before she left the ways, and immediately on being launched she proceeded to the South Dock under her own steam to load. The vessel was named Luda by Mr. Kirkley, of Gateshead.

Messrs. Raylton, Dixon, and Co., of Middlesbrough-on-Tees, have launched a steel screw steamer named the Haitan, which has been built by them to the order of Mr. J. S. Lapraik, for the Douglas Steamship Company, Limited, of Hong Kong. Her principal dimensions are: Length over all, 284 ft. 6 in.; breadth, 35 ft.; depth moulded, 26 ft. 3 in. She will be fitted with triple-expansion engines of 1700 indicated horse-power, having cylinders 25½ in., 42 in., and 67 in., and 42 in. stroke, by Messrs. Richardson, of Hartlepool.

On Saturday afternoon there was launched from the North Sands shipbuilding yard of Messrs. Joseph L. Thompson and Sons, a steel steamer of 3300 tons dead-weight carrying capacity. This vessel is of the three-deck type, with entire steel main deck, steel upper deck for half length, and six steel bulkheads carried to the height of the upper deck. The engines, of 1200 indicated horse-power, of the triple-expansion type, are being built by Messrs. T. Richardson and Sons. The vessel was named the Thomsonian (*pro. tem.*) by Mrs. Septimus Glover, of London. This vessel makes a total tonnage launched by the firm of 236,569 tons on the North Sands yard since February, 1846, including over 41,500 tons of wood and iron sailing vessels.

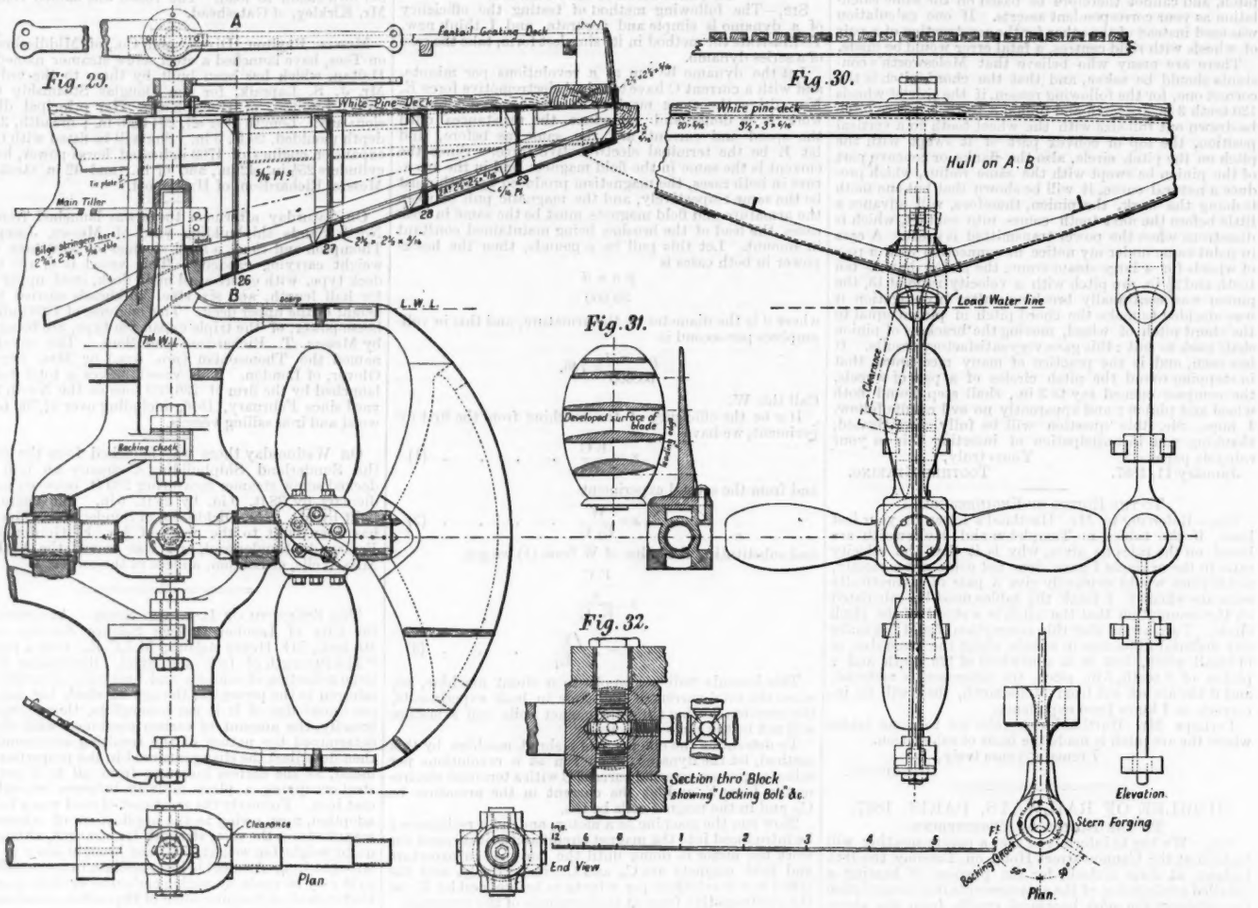
On Wednesday there was launched from the yard of the Sunderland Shipbuilding Company an iron spar-decked screw steamer measuring 280 ft. between perpendiculars by 38 ft. 9 in. by 25 ft. 6 in. The engines are built by Mr. John Dickinson, of Sunderland. The vessel has been built to the order of Mr. F. Gordon, of the Esplanade, Sunderland, and was named the Ardbeg by Miss Wells, of London, a niece of the owner.

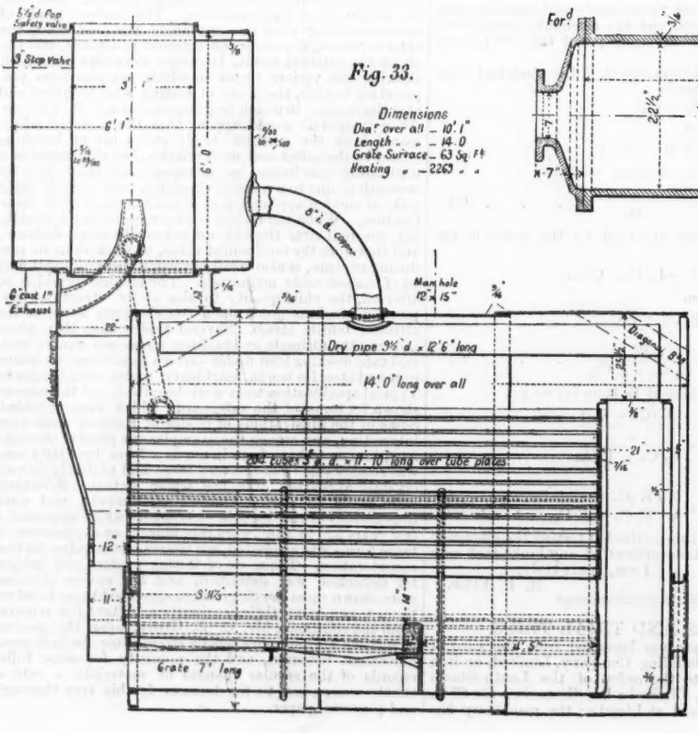
THE STRENGTH OF IRON AND STEEL.—At a meeting of the City of London College Science Society, on the 4th inst., Mr. Henry Adams, M.I.C.E., read a paper on "The Strength of Iron and Steel," illustrating it by a large collection of samples and numerous diagrams. He referred to the present as the age of steel, but said that our knowledge of it is yet incomplete, though speaking broadly, the amount of carbon combined with the iron determined the nature of the resulting compound. He then described the changes caused in the properties of the metal, as the carbon increases from *nil* to 5 per cent., steel occupying a place midway between wrought and cast iron. Formerly the great cost of steel was a bar to its adoption, now, owing to the application of science to its manufacture, the cost, strength for strength, although not quite weight for weight, has been brought down to that of wrought iron. As steel is intermediate in its constituents, so it may be made by adding carbon to wrought iron, as in blister steel, or burning some of the carbon out of cast iron as in Bessemer steel. The effect of impurities was noted, particularly of phosphorus and sulphur, and cases mentioned in which iron containing these could be used with the minimum of inconvenience. The various kinds of stress and strain were then explained, the load being the external cause, the stress the internal resistance, and the strain the external result. Diagrams were then exhibited, showing the various forms in which samples were prepared for testing, the mode of testing was described and also the manner in which the measurements were taken. At first sight it would appear that the material which would bear the greatest steady stress before breaking would be the safest and most reliable, but this would be a misleading conclusion, as in many cases this apparent strength is due to a want of elasticity, and a very slight jerk, or sudden application of a small stress would cause fracture. When the failure occurs without much stretching, the pull acts through an extremely small distance, and therefore the mechanical value, or work done in producing rupture, is also small, although the pull itself may be of considerable magnitude. The toughness, which is, after all, the chief quality to aim at for structural purposes, depends as much upon the elasticity as upon the ultimate tensile stress. Several tables were then given showing the ultimate or breaking stress per square inch, and safe working load under various conditions, including iron and steel for use in machinery under variable loads. Typical specification tests were described, and the reasons shown for some of the safeguards which were provided. Some of the illustrations of modes of fracture were very interesting, and among the examples one piece of wrought iron, known to have been in use as a lever for fifty years, was remarkable from the very large and perfectly formed crystals appearing over the whole section. Selections were made from Hodgkinson's experiments, and some illustrations of the fracture of test-bars which appeared a few years ago in *Iron*, were reproduced; an explanation of these forms was suggested, but the subject requires further consideration. The mode of testing girders and bridges for deflection was described, and the curves obtained were shown upon the diagrams exaggerated three hundred times to emphasise their peculiarities. After a few remarks from the chairman, Mr. C. E. Grove, upon the gradual elongation of iron under tensile stress after the first great movement occurred, and the necessity for some fuller records of the secular changes of materials, a vote of thanks was passed to the lecturer for his very thorough and practical paper.

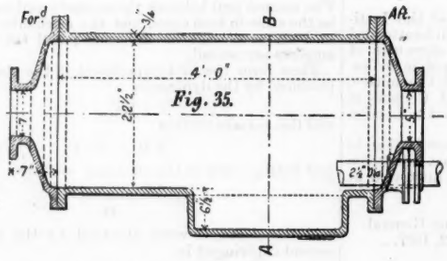
DETAILS OF FIRE BOAT FOR THE CITY OF CLEVELAND.

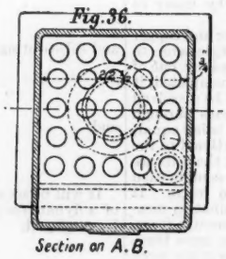
CONSTRUCTED FROM THE DESIGNS OF MR. WILLIAM COWLES, ENGINEER, NEW YORK.

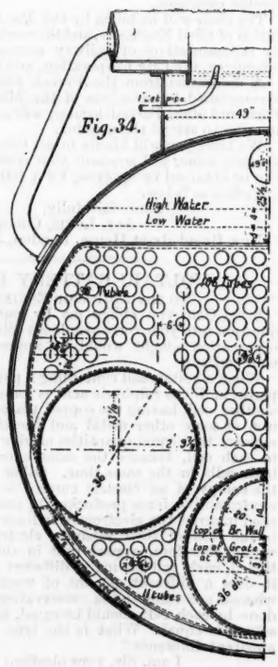
(*For Description, see Page 45.*)











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With a Two-Page Engraving of FIRE BOATS FOR THE CITY OF CLEVELAND AND CITY OF CHICAGO.

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Ordinary meeting, Tuesday, January 18th, at 8 p.m. Paper to be further discussed: "The Use and Equipment of Engineering Laboratories," by Professor Alex. B. W. Kennedy, M. Inst. C.E.—Students' meeting, Friday, January 21st, at 7.30 p.m. Paper to be read: "The Use of Cast Steel in Locomotive Construction," by Alfred J. Hill, Stud. Inst. C.E.

PHYSICAL SOCIETY.—January 23rd, 3 p.m. "On the Permanent and Temporary Effects on some of the Physical Properties of Iron Produced by Raising the Temperature to 100 deg. Cent.," by Mr. Herbert Tomlinson. "On some New Measuring Instruments used in Testing Materials," by Professor Unwin, F.R.S.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, the 19th inst. An ordinary as well as the annual meeting of the Society, at 25, Great George-street, Westminster. The following papers will be read at the ordinary meeting, at 7 p.m.: "On the Identity of Cloud Forms all over the World; and on the General Principles by which their indications must be read," and "On the Cloud to which the name 'Roll-Cumulus' has been applied," by the Hon. Ralph Abercromby, F.R. Met. Soc. These papers will be illustrated by pictures thrown on the screen by a limelight lantern. The meeting will be adjourned at 8 p.m., in order that the annual general meeting of the Society may be held, when the report of the Council will be read, the election of officers and Council for the ensuing year will take place, and the President (Mr. W. Ellis, F.R.A.S.) will deliver his address.

THE PARKES MUSEUM, 74A, MARGARET-STREET, W.—Thursday, January 20th, 1887, at 5 o'clock, when a lecture will be delivered by Mr. M. Ogle Tarbotton, M. Inst. C.E., on "Engineering and Architecture in relation to Sanitary Science." The chair will be taken by Captain Douglas Galton, R.E., C.B., D.C.L., F.R.S.

ENGINEERING.

FRIDAY, JANUARY 14, 1887.

ALUMINIUM.

THERE is probably no problem which, while certainly capable of—or more properly perhaps adapted for solution—has so long remained the El Dorado of chemists and metallurgists, as that of the introduction of metallic aluminium as an article for every-day use. While it remains at between 40s. and 50s. per pound, this consummation does not seem near, and it is not easy to know even now whether to regard pure aluminium as a precious metal or a curiosity of manufacture; probably in view of the quantity of jewellery and *objets d'art* which have been made with it, the former classification is the more correct, though it is not mentioned in the census relating to precious metals recently published by the Statistical Department of the United States. The intrinsic value of the pure aluminium made in France, which still remains the chief seat of its manufacture, cannot be regarded as considerable, and it is in the form of its alloys, which possess much value on account of their marked physical properties, that the value and immediate future of aluminium would seem to lie. In a paper read last year by Dr. Sterry Hunt before the American Institute of Mining Engineers, it is stated that remarkable results are obtained by alloying small quantities of aluminium with copper and nickel; one such compound broke at a strain of 49 tons to the square inch, with an elongation of 35 per cent., and a 10 per cent. aluminium bronze broke at 48 tons; such an alloy would be harder than gold alloyed for coinage, and would possess a specific gravity of about 7.8.

Some fifteen years ago a considerable quantity of pure aluminium was imported from France in the form of jewellery, but whether the quality was inferior, or whether it was too absolute a test of the question whether pure aluminium would withstand oxidation and other chemical influences, it is certain that, although in shops the work looked extremely pretty, it failed to make headway, and distinctly suffered from tarnishing, and became brittle. This result was probably due to the action of atmospheric ammonia, as authorities are agreed that the metal withstands the action of acids better than alkalies. The aluminium industry, if the term is allowable, is more indebted to the late Emperor Napoleon than many people are aware; it was he who "retained" that eminent chemist and physicist, Henri St. Clair Deville, for the investigation of the problem of its production, with the result that the process devised by him now some thirty years ago, remains to this day the principal method of manufacture. In a shop in the Boulevard Poissonière, Paris, owned by the Société de l'Aluminium, may be seen the latest application of the metal. The Société does not manufacture, but is supplied under exclusive contract by M. Pechiney, of Salindres, and as recently as March, 1883, the late Mr. Weldon, F.R.S., spoke of M. Pechiney as the only commercial manufacturer of aluminium in the world. The process in use remains with but slight changes in detail as Deville left it, though such modifications have been introduced as to lower the price, which was quoted at 250*l.* per hundredweight in 1867, to 50*l.* per hundredweight in 1881.* The price, however, has more than quadrupled since then if we may accept Mr. Nordenfelt's recent statement that he was not aware that aluminium could be bought at less than 48s. per pound. The most expensive part of the manufacture of the metal is the preparation of the anhydrous chloride and its subsequent reduction by sodium. Some three years ago there was a flutter in the metallurgical world consequent upon the pretended discovery of a process by which aluminium could be obtained at 100*l.* per ton. On examination of the published details of the process, the fallacy was obvious, the new departure turned out to be in the preparation of the alumina used, and it was subsequently shown that the new method, so far from being less costly, was more costly; the collapse of the process as such was therefore the result. The French method being of such historic interest may be described as follows.

Alumina is prepared by furnacing bauxite with carbonate of soda, dissolving out the soluble aluminate of soda, and treating this solution with carbonic acid; on washing the precipitate pure alumina will be obtained. This alumina is dried, heated strongly with carbon, and chlorine passed over the heated mixture; the chloride of aluminium is then decomposed by metallic sodium. We repeat that this process is commercially successful, but when we consider that to reduce 1 lb. of aluminium from its chloride, about 3.5 lb. of sodium are required, and that the sodium will cost at least 1s. per pound, we can understand the high cost of the finished metal. Mr. Weldon gave the figures representing the relative cost of the three operations on which the Deville process depends, as 9.67, 33.4, and 56.93 per cent. respectively of the total cost, so that the future of aluminium lies, either in cheap production of the haloid salts of aluminium and metallic sodium or the discovery of an entirely new process. Frischmuth's process has for its object the saving of this expensive item of sodium, and consists in producing sodium vapour direct from sodium salts and carbon. Considerable success seems to have attended this modification; and it is now, we believe, being worked at Philadelphia. Mr. Frischmuth made the cap of the Philadelphia monument, weighing 117½ oz.; this cap is spoken of as "huge;" it was to have been burnished, and was stated to be "going to shine like polished silver for ever."

It has for many years been regarded as entirely hopeless to attempt the direct reduction of compounds of alumina by carbon, and even Mr. Weldon stated that metallurgists might as well hope to get five from the product of two and two as to attempt it. Since, however, the supposed proof of the absurdity lay in certain physical laws of heat, of combination, &c., and we have no knowledge of how far those laws hold good at elevated temperatures, the objection has not, we think, much weight, and, without being wise after the event, the production of aluminium by the Cowles Electric Smelting Company, in which process, which has been fully described by us,* only the direct reduction is mentioned, will seem to controvert the view which so many, in common with Mr. Weldon, held. It is well known that the temperature of the electric arc is the temperature of dissociation, and therefore alumina cannot exist in it. When to this the presence of carbon is added, we have conditions which upset theoretical considerations, and with suitable apparatus the production of aluminium is an accomplished fact. Seeing then that the direct reduction by carbon is effected by simply augmenting the heat, it follows that the production in a furnace, other than an electrical furnace, is within the bounds of possibility. It will be obvious that the reduction will be facilitated in certain cases by using other compounds than the oxide, and many patentees have built their hopes on these compounds. The double sulphide of aluminium and sodium produced by heating together carbon, sulphur, carbonate of soda, and alumina, when highly heated with alumina, is said to set the metal free. Manganese will also reduce aluminium from its sulphide or haloid salt, displacing the sulphur, which goes off as sulphur. This reaction formed one of the last patents which Mr. Weldon took out, and he proposed to produce the sulphide, or haloid salts of aluminium, by the double decomposition of cryolite and the sulphide, chloride, or iodide of either sodium or calcium. An interesting process, similar to the above, is described in *Dingl. Polyt. Journal*, cclii., pages 515, 519, in which Herr Niewerth mixes ferro-silicon with cryolite in equal proportions and heats to fusion; volatile silicon fluoride is said to be formed, while the aluminium is left as an alloy with the iron. On fusing this with copper an aluminium-bronze is obtained and only a small amount of the aluminium is said to remain with the iron. It is an alloy of the metal and iron, made by the Cowles Electric Smelting Company, which is used in the Mitis casting process. Its average composition is aluminium, 7.5 per cent.; silicon, 1½ per cent.; carbon, about 4 per cent.

Such then is the position of the aluminium in-

* See ENGINEERING, vol. xxxiv., page 603.

* See ENGINEERING, vol. xlii., page 39.

dustry at the present time. We have pointed out that the resistance of the metal to oxidation has not been proved, nor will the mechanical properties as evidenced by the latest researches tend to strengthen the high opinion of its value, which in many cases has, we think, been exaggerated. Thus a wire of No. 18 gauge gave a strain averaging 7.9 tons per square inch; this is extremely low. Cast and hammered aluminium gave 7 tons; by cold hammering 13.2 tons could be obtained. Again, the latest determination of the specific gravity of aluminium is 2.583,* which is higher than that generally ascribed to it. The difficulty of working aluminium is very great, and until two or three years ago no means were known for even soldering it, either to itself or other metals. Comparing these results with those obtained from its alloys, it would seem, as we have said, that the future of aluminium lay not so much in the preparation of the pure metal as in the production of its much more controllable alloys, some of which promise to possess a high value as constructive materials.

IRON SHIPBUILDING IN THE UNITED STATES.

THE death of Mr. John Roach, a few days ago, at New York, removes from the arena of active shipbuilding operations, the most prominent figure in the shipbuilding industry of the United States, and supplies a fitting occasion for a brief review of the progress and prospects of the industry with which he was so long connected.

Although the construction of iron ships has not hitherto made very substantial progress in America, the industry is by no means a new one in that country. On the contrary an iron vessel, named the Codorus, was built in Pennsylvania for service on the Susquehanna River, as far back as 1825. In 1836 a steamer was built of iron at New York of 600 tons burden, which was employed in the mail service to New Orleans. Boston turned out an iron revenue cutter in 1841, and in the following year a line of small iron steamers designed to trade between that State and Hartford, Connecticut, was built in Pennsylvania. The exceptionally low price of iron at this period appears to have had something to do with stimulating the development of the iron shipbuilding industry, which continued to make progress until its career was cut short by the war of 1861.

For some years after the war, iron shipbuilding appears to have been practically at a standstill. This was no doubt largely due to the great increase in the price of the materials employed, induced partly by higher tariff duties and partly by the greater cost of labour. So far as the available records throw light on the subject they show that the industry was limited to the construction of 2801 tons in 1868, which, however, advanced to 8281 tons in 1870; to 21,632 tons in 1875; to 25,582 tons in 1880; and to 32,000 tons in 1885. From first to last about 600 vessels were built in iron down to 1883, but the data at command are not sufficiently exact to show the tonnage built in each year, nor even the total of the whole.

The connection of John Roach with the iron shipbuilding industry of the United States commenced in 1868, when he purchased the Morgan Iron Works, at Chester, Pennsylvania, premises which he adapted, and afterwards carried on for many years, as a marine engine building works. He had previously carried on engine works in New York City, where he built the engines for the Dunderberg, afterwards rechristened the Rochambeau, a monster ironclad for that time of day, which Mr. W. H. Webb, of New York City, built about 1865 for the United States service, but which was afterwards sold to the French Government. This vessel was 380 ft. long and 72 ft. beam, with 23 ft. depth of hold amidships, and a casemate of about 8 ft. high superimposed. The sides of the casemate were 3 ft. thick, and were set at a slope of 35 deg., in order to allow of the glancing of shot. Her displacement was about 6900 tons, and her engines developed 5000 horse-power. She registered 5090 tons, and was said to be the fastest armed steamer in her day, her speed averaging 15¾ miles per hour. The connection of Mr. Roach with this and some other notable vessels built about the same time secured for him a high reputation as an engine builder.

It was not, however, until 1872 that Mr. Roach commenced to build ships himself at Philadelphia. Here he purchased in 1871 a tract of ground, having a frontage to the Delaware River of 2500 ft., and covering altogether about seventy acres. At the point were he set down his shipbuilding works, the river is about a mile wide, so that there is ample facility for launching vessels of the largest size. Below the shipyard, which was equipped in the most modern style, Mr. Roach erected rolling mills, as well as a blast furnace for the production of his own iron. A high authority remarks upon these adjuncts that "they cover about thirty acres, and employ about 800 men, and it is not too much to say that they constitute (1880) the best plant in the United States for making plates and armour of iron and steel, and steel castings. It is an interesting fact that at these two establishments, owned by one firm, iron and steel ships can be built, beginning with the ore and ending with the finished steamer completely equipped for sea." This conjunction of facilities is not unique. Palmer's Company, at Jarrow-on-Tyne, possesses just the same variety of concentration of resources; but the combination is nevertheless a rare one, and it proves the comprehensive grasp of the man by whom it was conceived and consummated.

The first vessel constructed at the Chester shipbuilding yard was the City of Waco, a screw steamer of 1549 tons, having four boilers, each 10 ft. in diameter by 9 ft. 6 in. long, and engines of 30 in. and 56 in. cylinders by 13 ft. stroke. In the same year, other five vessels were launched, the largest of 2906 tons, and the smallest of 750 tons. In the following year eight vessels were constructed, varying from 553 tons to 5080 tons, the latter being a twin ship to the City of Tokio, launched in the following year, and christened the City of Peking. Both were screw steamers, 419 ft. long by 47 ft. 4 in. broad, with ten boilers 13 ft. by 10 ft. 6 in., and engines of 51 in. and 88 in. by 54 ft. stroke. They were, indeed, the largest vessels that were ever launched from the Chester shipyard, whence no other vessel exceeding 3000 tons burden was subsequently turned out until 1878, when the City of Para was built for the Pacific service, followed in the same year by the City of Rio de Janeiro, of about the same dimensions. With the exception of three vessels built in 1881, all the vessels constructed by Mr. Roach subsequently to 1880 were of 2000 tons burden or upwards, and all except three or four were screw steamers.

The only other American firms that have any claim to compare with Mr. Roach's as an iron shipbuilding concern, are those of Messrs. Cramp and Sons, and Harlan and Hollingsworth, of Wilmington, Delaware, which latter, however, had begun to build iron vessels thirty years before Mr. Roach launched his first ship at Chester. Up to the end of 1882, the Wilmington firm had launched a total of 132,606 tons of iron shipbuilding, the largest being the Excelsior steamship, 3264 tons, constructed in that year for Morgan's Louisiana and Texas Railroad and Steamship Company. The same firm has constructed two iron vessels, each of 3000 tons, for the Pacific Mail Steamship Company, the one to trade between New York and Aspinwall, and the second to trade between San Francisco and China. They have also constructed the Wyandke and the Old Dominion, each of over 2000 tons, to trade between New York and Richmond. But generally speaking the vessels built by this firm and by all the others in the United States have been of much smaller dimensions than those constructed by Mr. Roach, who may be said to have been, *par excellence*, the iron shipbuilder of the United States. The results obtained with some of his ships were remarkable. The twin steamers City of Peking and City of Tokio were for a number of years employed in the trade between San Francisco and China, and proved very economical in fuel. Two other steamers, the Para and the Rio de Janeiro, were constructed at the builder's own risk with a view to the Brazilian trade, from which, however, they were ultimately withdrawn on being acquired by the Pacific Mail Company. Others of Mr. Roach's steamers have displayed remarkable speed. The City of Washington, for example—of 2618 tons, 320 ft. in length, 38 ft. breadth, and 27 ft. 7 in. depth, having boilers 18 ft. by 18 ft., and engines of 40 in. and 74 in. cylinders by 72 ft. stroke—made the run from Havana to New York, a distance of 1230 miles, in 75 hours 21 minutes—a run which was claimed at the time (1879) as the fastest on record for a consecutive period of equal duration. Subsequently, however, even this *tour de force* was eclipsed by the s.s. Newport, another of Mr. Roach's steamers, which made the same run in 72 hours and 15 minutes.

Mr. Roach's remarkable success in an industry where everything appeared adverse to progress, is ascribed to exceptional business qualities, and especially to his ingenuity in adapting vessels to the trade in which they were to be employed. Thus, "a special study would be made of the kinds of cargo carried by the vessels in a particular coasting trade, and an idea would be formed of a ship which would carry more of the given varieties of goods on a lighter draught of water, and at a faster rate of speed than the vessels already in the trade. This idea would be worked out in a ship in which the builder would take perhaps a greater interest. . . . Measures are taken to secure willing work from the men. They are encouraged to be inventive and faithful by a system of rewards and promotion."

The last twelvemonths of Mr. Roach's life was, however, and in spite of his energy and capacity, clouded by misfortune. For this, the circumstances of the country, rather than his own, may be held responsible. From the first, he had to struggle against tremendous odds, alike in the higher cost of materials, and the greater expense of labour, as compared with European shipbuilders. The American tariff laid a heavy hand, and lays it still, upon American shipbuilding in every direction. The duty on plate iron is 69 per cent. *ad val.*; on tubes, 67 per cent.; on wire ropes or chains, 57 per cent.; on cables, 56 per cent.; on sheet iron, 51 per cent.; on screws, 50 per cent.; and so with other articles that enter more or less largely into steamship construction. Labour, again, is quite 60 per cent. higher in the United States than in England. It is computed that in the iron shipbuilding industry of the United States, 60 per cent. of the total cost goes for materials and 40 per cent. for labour. But whatever the exact proportions of each may be, both alike are handicapped, and the marvel appears to be that, against such odds, Mr. Roach could make such headway as he actually did.

The total number and tonnage of iron ships built in the United States during the ten years ending 1885 were as under:

—	Sailing Ships.		Steamers.		Total.	
	Number	Tonnage.	Number	Tonnage.	Number	Tonnage.
1876	..	..	25	21,346	25	21,346
1877	..	..	7	5,927	7	5,927
1878	..	..	32	26,960	32	26,960
1879	..	..	24	22,008	24	22,008
1880	1	44	30	25,538	31	25,582
1881	1	36	41	28,320	42	28,356
1882	..	..	43	40,097	43	40,097
1883	1	2633	34	37,613	35	39,646
1884	3	4432	41	31,200	34	35,632
1885						

It comes, then, to this, that the total iron tonnage launched on American waters has not, in any one year, exceeded the tonnage that has some times been launched by a single firm in Great Britain within the same period. This state of affairs has occupied the serious attention of the Government of the United States, which has recently passed two measures designed to produce an ameliorative effect, the first being the Dingley Bill, adopted in 1884, whereby American shipping was relieved from onerous taxes and other burdens; and the other, the insertion in the Post Office Appropriation Bill of the same year, of a clause authorising a payment of 50 cents a mile to American vessels carrying foreign mails. But neither expedient appears as yet to have produced the desired effect, nor is it likely that they will, under a system that entailed ultimate disaster upon a man of Mr. Roach's experience and resources.

THE WEATHER OF 1886.

ACCORDING to the averages of observed data the weather of 1886 was nearly normal. On the whole it was 1 deg. colder than usual, but the rainfall was in excess in Ireland and in defect in the east of England. The mean atmospheric pressure and temperature for the entire year, at extreme positions to which the Isle of Man is central, were as follows:

Positions.	Mean Pressure.	Difference from Normal.	Mean Temperature.	Difference from Normal.
	in.	in.	deg.	deg.
North ..	29.76	below 0.01	45	below 1
South ..	29.92	,, .05	51	,, 1
West ..	29.83	,, .04	49	,, 0
East ..	29.88	,, .02	48	,, 1
Central ..	29.86	,, .04	48	,, 1

* Mallet, Chem. Cent. Blatt., xiii., page 772.

FIRE BOATS FOR THE CITY OF CLEVELAND AND CITY OF CHICAGO.

CONSTRUCTED FROM THE DESIGNS OF MR. WILLIAM COWLES, ENGINEER, NEW YORK.

(*For Description, see Page 45.*)

Fig. 14.

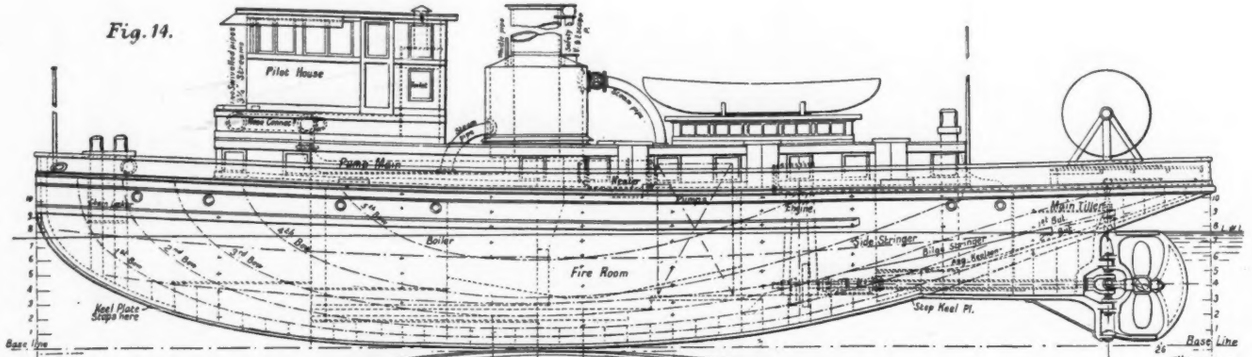


Fig. 15.

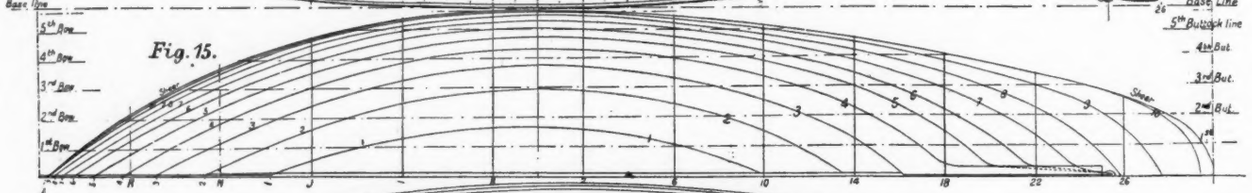


Fig. 16.

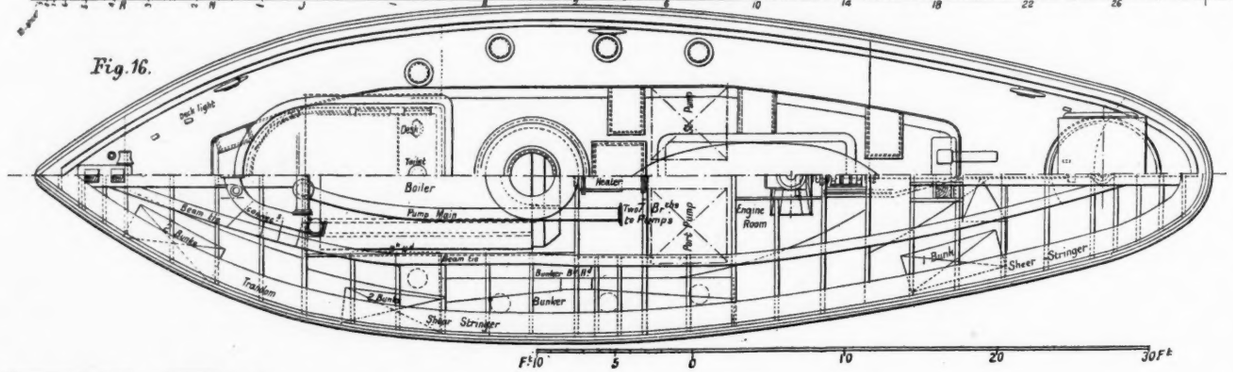


Fig. 17.

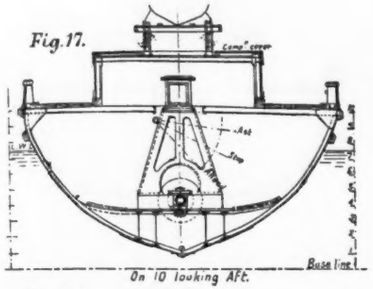
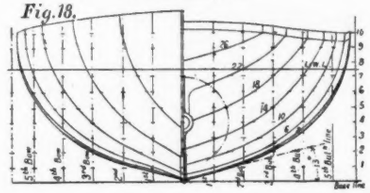


Fig. 18.



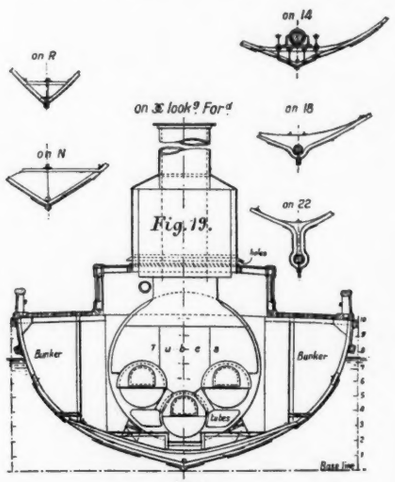


Fig. 19.

Fig. 20.

Diameter over all 11'. 4½"
Length 16. 0
Grate Surface 84 Sq. Ft
Heating 3051 " "

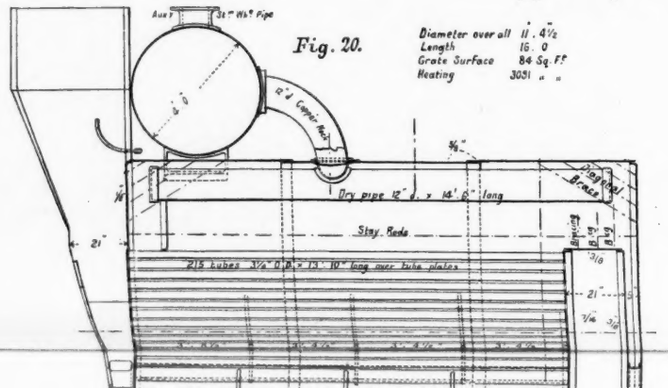


Fig. 21.

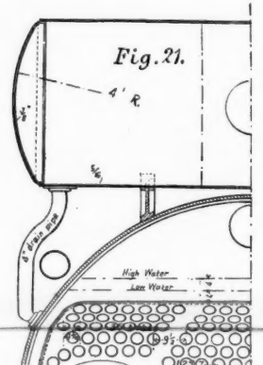
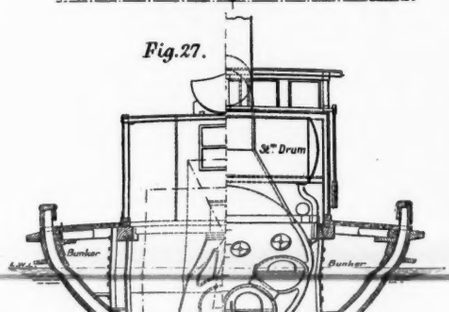


Fig. 27.



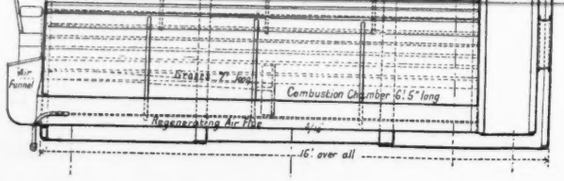


Fig. 22.

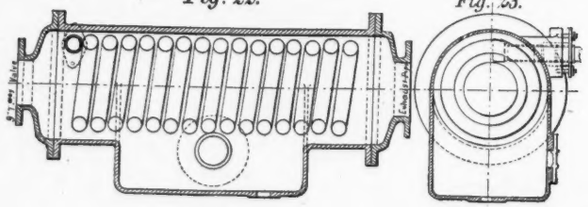
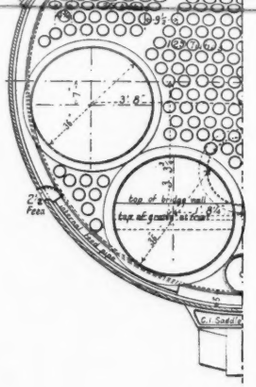


Fig. 23.



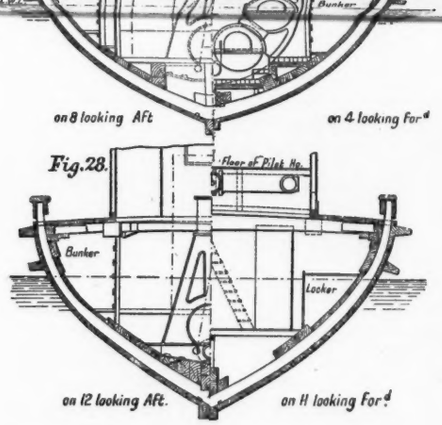


Fig. 28.

Fig. 24.

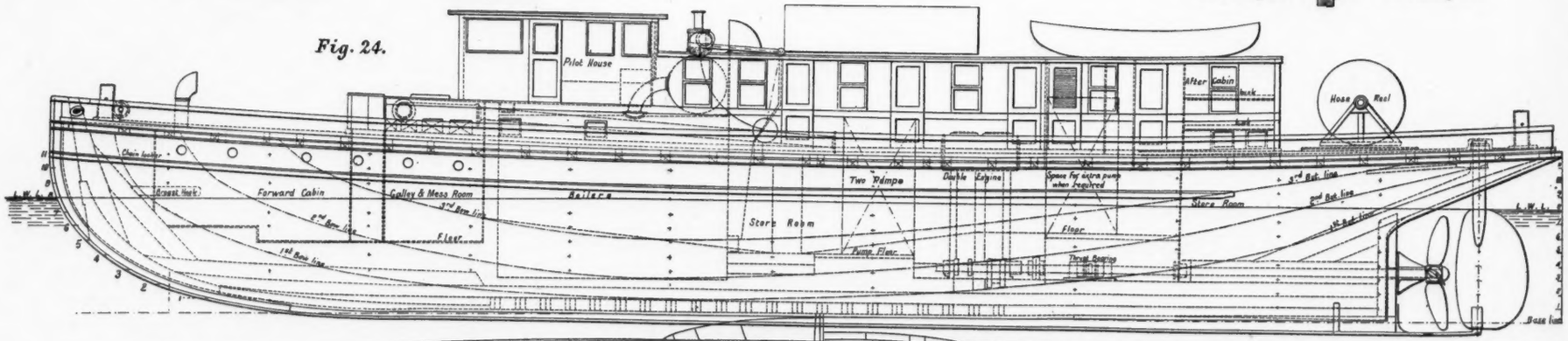


Fig. 25.

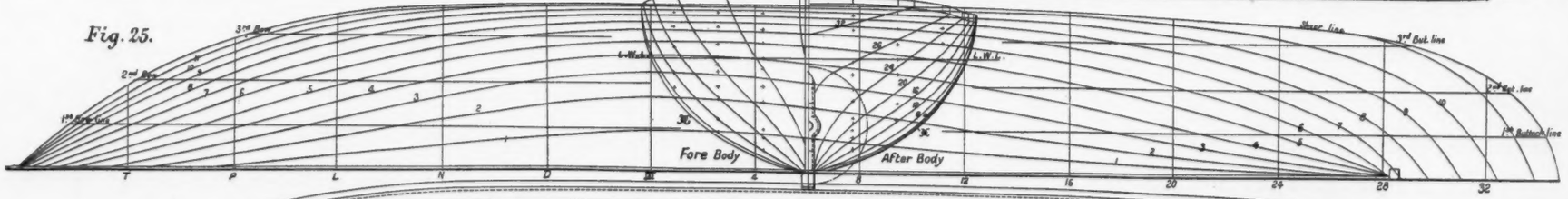
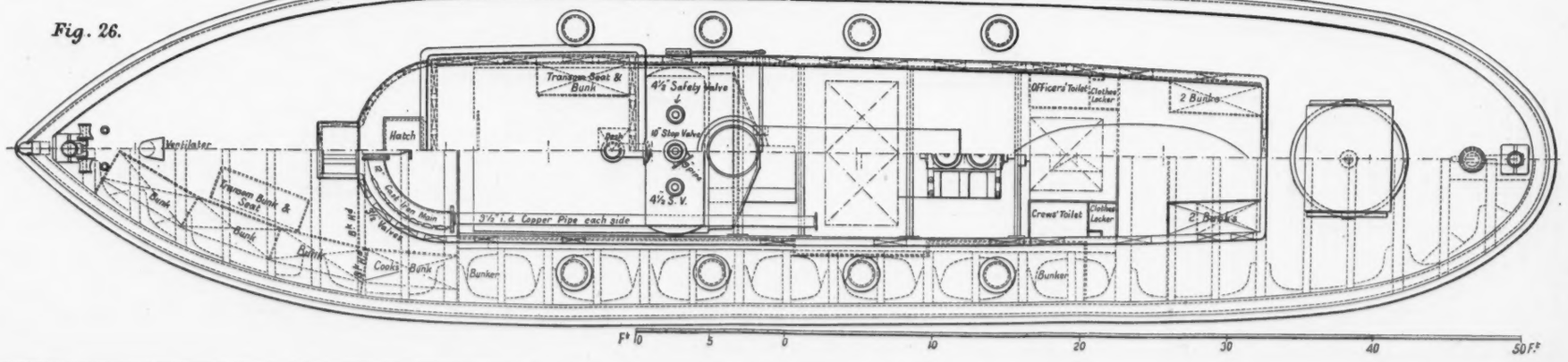


Fig. 26.



The aggregate frequency and amount of rain may be estimated tolerably well from the following results :

Places.	Rainy Days.	Amount.	Difference from Normal.
		in.	in.
Sumburgh	270	35.92	below 1.57
Scilly	237	35.09	,, .38
Valencia	271	60.20	above 2.72
Yarmouth	194	24.24	below 4.37

The monthly resultants of the winds give for the year's resultant W. by S. equivalent to a wind from that direction on 67 days, which is about the normal annual resultant.

The duration of bright sunshine, estimated in percentage of its possible duration, for the entire year was 29 for these islands generally, for the Channel Isles 39, east England 33, south England 32, south-west England 31, east Scotland 30, north Scotland and south Ireland 28, north-west and central England 27, north-east England and west Scotland 26, north Ireland 24. Ireland had 4 per cent. less sunshine in 1886 than in 1885, while north Scotland and north-east England had about as much more ; in the other districts the amounts for these years are almost alike.

The values for atmospheric pressure and temperature are nearly the same as they were for 1885 ; but the rainfall was slightly greater, except in the east, where it was less. The pressure was very nearly normal, the temperature about one degree colder than ordinary. The rainfall was less than the average for Great Britain, and slightly more for Ireland. In the east of England the deficiency of rain was relatively large.

The months may be characterised as follows : January was cold, frost and thaw in sudden alternations. February was quiet and gloomy, "not so bad for thirty years." The winter was cold. March was cold, with much snow in first week. April was rather cold, changeable. May was cold, changeable, heavy local rains. The spring was cold. June was cold and dry. July was rather cold. August was rather cold. The summer was cold and gloomy. September was warm and fine. October was warm. November was warm, quiet, foggy. The autumn was fine and warm. December was cold and stormy. Thus the first nine months were all cold, and followed by three warm ones.

The notable events as regards the weather of 1886 may be specified as follows : The lowest temperature of the year was recorded at Rothampstead, 6 deg., on January 8th. On the 6th, 8 in. of snow covered London. On the 13th a severe thunderstorm with much rain and hail occurred in central England. March 7th, the minimum temperature at Stoke-on-Trent was 7 deg. April 11th, 5 in. of snow fell over Worcestershire ; and on the 29th snow fell on North Wales and north Scotland. May 12th, the snow fell on north England and south Scotland ; severe thunderstorms occurred over the metropolitan district on the 22nd and 23rd ; and continuous rain, 1.16 in., at London on the 24th. June 10th, 9.30 to noon, intense darkness in London ; 14th, a destructive tornado occurred at Deal ; 14th to 21st, inclement, cold, and cheerless weather in east England. July 1st and 5th, each gave 15 hours of bright sunshine to Kew ; on the 13th, 2.2 in. of rain fell at York ; on the 4th, the highest temperature for the year, 89 deg., was recorded at Southampton. October 14th to 18th, a long and severe tempest prevailed. November 24th, barometer attained 30.8 in. ; 23rd to 26th, continuous nasty fog in London. December 8th, 8 A.M., barometer 27.58 in., at Belmullet, having fallen 1.76 in 14 hours, at the rate of 0.13 per hour ; at 1.30 P.M. the barometer at Belfast fell to the extraordinary low point 27.38 ; on the 9th, 4.30 A.M., the wind attained 23.5 lb. on the square foot at Greenwich ; 26th, severe gale and large fall of snow in south England, 8 in. in London to 12 in. near Southampton, between 8 P.M. and 8 A.M. The destruction of telegraphs by this storm is probably without a parallel. Snow falling quietly has frequently overstrained the wires and broken them. In this storm the wind alone would have done much havoc ; but, notwithstanding the wind, the snow settled on the wires, and thus formed a larger surface for the wind to act upon. London streets were blocked by the wreck of wires, and had not the ordinary night traffic been stopped by the inclemency of the weather the injury to life and limb would have been extensive ; as it happened only property suffered.

A reading of the barometer at the sea-level lower than that observed at Belfast was recorded at Ochtertyre, 27.33, on January 26, 1884, and an equally low pressure, 27.33, was observed on board the steamship Tarifa, in latitude 51 deg. N., and longitude 24 deg. W., on February 5th, 1870. These are absolutely the lowest atmospheric pressures that have anywhere been recorded at the sea-level, from reliable instruments.

STREET CLEANING IN PARIS.

By H. VIVAREZ.

(*Continued from page* 2.)

IN our last article we gave a brief review of the manner in which the work of cleaning streets in Paris had been dealt with by legislation during the last five centuries. Before examining in detail the actual regulations that control this important service, it will be useful to describe generally the manner in which the service is organised, and in this will be noticed indications of the different temperaments that characterise the two nationalities. Whilst in England decentralisation and independent action in a number of districts is preferred, in France the preference for centralisation is visible in almost everything. Thus the direction of all the work required for the city of Paris is vested in one hand. In London the work of street cleansing, as well as very many other public services, is divided among forty parishes, all of them acting independently of each other. The Direction of Works in Paris, presided over since many years by M. Alphand, comprises seven principal divisions.

1. The public streets ; temporary concessions, and construction of sewers.
2. Promenades and plantations ; public and private lighting ; permanent concessions connected with streets.
3. Water supply and drainage.
4. The purification and control of the Seine ; the utilisation of sewer water ; irrigation ; the establishment at Gennevilliers.
5. Railways in and around Paris ; the Paris Cemetery of Marcy-sur-Oise ; the control of vehicles, telephones, and pneumatic clocks.
6. The consultative engineering department.
7. The vicinal service of the Department of the Seine.

The first of these branches is the only one that need concern us in the subject under investigation. It is separated into two divisions, each having an engineer-in-chief at its head. The first division comprises all the central arrondissements, and is subdivided into three sections. The first section includes the 1st, 2nd, 3rd, 4th arrondissements ; the second, the 5th, 6th, and 7th ; and the third, the 8th, 9th, and 10th arrondissement. The second division, dealing with the external arrondissements of Paris is divided into five sections for 11th and 12th ; the 13th and 14th ; the 15th and 16th ; the 17th and 18th ; the 19th and 20th arrondissements. Each of these various sections is under the control of an engineer. The personnel of this important service is recruited from the Ponts et Chaussées. They are nominated by the Minister of Public Works, and are, while attached to the service, subject to the various rules of advancement, &c., belonging to their corps. Their pay and allowances come from the Ville de Paris, and the funds set aside for their pensions are placed in the Government Treasury. The sub-engineers and foremen of the Municipal Service are nominated by the Prefect of the Seine, and subscribe to the pension treasury of the prefecture. In the first and oldest division, the public road service and scavenging were originally separate, the latter being, before 1859, within the functions of the Prefect of Police. In the second or suburban division, which was organised in 1860, the two services were combined from the commencement. The personnel in the first division comprises 95 agents for the public roads, and 58 for scavenging ; that of the second includes 103 for the former, and 54 for the latter service. The total staff thus numbers 210 agents. Up to 1873, the work of street sweeping was regulated by the police ordonnance of 1853. At the former epoch the greater portion of it was abrogated by the passing of the law of March 26, 1873, which converted into a municipal tax, the obligation imposed on the inhabitants to sweep the areas used for traffic. This law is contained in the two following articles : "1. From the date of the promulgation of the present law, the duty which falls upon proprietors and tenants of houses in Paris, facing roads used for public traffic, to sweep, each one in front and for the extent of his façade, to a width equal to one-half of the road aforesaid, and for a width not exceeding six metres, is now transformed into an obligatory municipal tax, levied according to a tariff decided upon by the Municipal Council, after examination, and approved by a decree, prepared under the form of an administrative public rule ; this tariff will be revised every five years. In fixing the tariff no account will be taken of the value of property, but only of the necessities of the traffic, and the sanitary and proper condition of the street. The tax, moreover, will not exceed the cost incurred by the Ville de Paris, by the sweeping of the total area for which the inhabitants are responsible.

"2. The payment of this tax will not exempt the proprietors and tenants of houses in public streets from the obligation imposed upon them by the existing police regulations, during periods of snow and frost."

Conformably with the foregoing first clause, there is prepared a statement every five years, showing the conditions of the streets in Paris, and classified into different categories. The following table, referring to the periods from 1884 to 1888, contains the actual tariffs charged.

No. of Classes.	A. Houses and other Buildings facing on Street. Francs per square metre	B. Constructions not on Streets, and inclosed by Walls, Railings, or similar Screens. Francs per square metre	C. Ground inclosed by Fencing, Hedges, &c., or not inclosed. Francs per square metre
1	0.70	0.525	0.35
2	0.60	0.45	0.30
3	0.50	0.375	0.25
4	0.40	0.30	0.20
5	0.30	0.225	0.15
6	0.20	0.15	0.10
7	0.10	0.075	0.05
8	0.08	0.06	0.04

The areas to be swept in Paris are :

	sq. metres.
For the first division	5,730,000
For the second division...	8,770,000
	14,500,000

or about 155,875,000 square feet, and assuming a mean tax of 0.38 franc to be charged per metre the total amount of the tax would be 5,510,000 francs, or 220,000*l*. The work of scavenging includes three distinct operations :

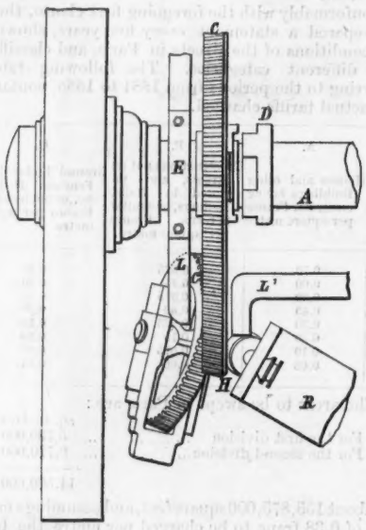
1. Sweeping by the city workmen.
2. Sweeping by mechanical means.
3. Removal of the mud, &c., collected.

Sweeping by hand is provided for by 122 stations, of which 52 belong to the first division, and 70 to the second. The former comprise each, one director, one foreman, and 25 or 30 workmen. The second, one foreman, four foremen, and from 16 to 20 workmen. Thus there is, in all, a staff of nearly 3000 labourers, male and female, under the control of 310 directors, foremen, and sub-foremen. In the first division the work is generally concentrated in the first half of the day, only the sub-foremen are retained during the afternoon for supplementary sweeping, flushing gutters and urinals, cleaning police stations, and the scavenging of the halles and markets. In the second division the work is not so heavy. Usually the whole day's work is concluded at 4 P.M., and the half-day at 10 A.M. In summer, sweeping is commenced at 3 a.m., and during winter at 4 A.M. The wages paid to the foremen are 100 and 105 francs for the 1st and 2nd class, and 80 to 85 francs for the workmen per month. Supernumeraries, the number of whom is very variable, are paid at the rate of 1 franc to 1.75 francs per half-day, according to whether they are lads, women, or men.

Mechanical sweeping effects an economy of two-fifths as compared with hand sweeping. The following gives the result of comparative experiment of scavenging by the two methods made over a distance of 22 miles. For this length a force of 60 men is required, divided into five brigades, and costs 135 francs, or 3.85 francs per kilometre (say 5s. per mile). For the sweeping machines there are required :

	francs
4 horses at 6 francs	24
4 drivers at 3 francs	12
12 sweepers	24
Wear of brushes	14
Maintenance	8
	82

or 2.34 francs per kilometre, a little over 3s. 5d. a mile. Two manufacturers supply the Ville de Paris with mechanical brushes. They are M. Sohy and M. Blot, the system of each being similar except in points of detail. They are composed of a one-horse frame, with a seat for the driver, behind whom is a roller about 6 ft. 6 in. long, spirally around which the bristles are mounted. The roller is oblique and can be raised or lowered at the will of the driver. As it advances the mud is turned aside, and is ultimately deposited in a line alongside the pavement. The annexed sketch represents the transmission mechanism in the Blot sweeper; A is the axle and R the roller. The former carries the loose wheel C gearing with the pinion *c* that transmits the motion to the shaft of the brush by the universal coupling H. The pinion *c* is hung between two iron brackets L L', which are fixed on the axle by means of the two collars E. This arrangement gives perfect freedom to the brush,



and allows it to follow any surface irregularities in the road. A lever placed within reach of the driver's left hand, allows him to stop the rotation of the brush when the work is finished, by moving the sleeve of the coupling D. Between the frames of the machine is a locker containing the various tools required for small repairs and adjustments. These machines weigh about 1700 lb. Worked at ordinary speed they can sweep over 6000 square yards per hour, equivalent to the work of 10 or 12 men. Their price is 40*l*., and the annual maintenance 8*l*., not counting the renewal of the brush, which lasts from 150 to 180 hours. These brushes cost each 70 francs.

The sweepings, either by hand or machine, accumulate along the side of the pavement, and require to be removed. This is made the subject of special contract for different districts, on a scale of charges adjusted every three years. The current schedule runs from January 16, 1884, to January 15, 1887. It deals with 18 districts, comprising No. 1, the first and second arrondissements; No. 2, the third and fourth, and the others one arrondissement each. Each district is contracted for on competition. From April 1st to September 30, the carting commences at 6.30 A.M., and is finished at 8.30 A.M. From October 1st to March 31, it lasts from 7 to 9 in the morning.

We need not enter into detail upon this part of the service, but will devote some space to describe the removal of the house refuse, which is done by the same contractors, and at the same time as the mud, and street detritus, in accordance with some regulations of quite recent date.

(*To be continued.*)

NOTES.

A New Ammunition.

The British patent rights for the new ammunition which has been adopted into the German army have, we understand, been acquired by Messrs. Latimer Clark, Muirhead, and Co., who are about to manufacture the ammunition at Millwall. It consists of several improvements, one of which is the bullet. The Lorenz bullet is composite, being partly of lead and partly of steel, and it possesses a great penetrative power. The charge is fired by compressed powder, a plan which is also found to be highly advantageous. The cartridges are so constructed as to keep good for years; and they are free from danger in store, as the exploder can be kept apart from them and only applied when they are about to be used. The bullet has also, we believe, been adopted in the French army.

New Russian Canal.

The Russian Government has contracted a loan of 25 million roubles with the firm of Hersent and Co., Paris, for the construction of the Perekop Canal in Southern Russia. M. Louis Caisseau, a French engineer of Suez Canal fame, is to be the chief engineer. The canal will establish a direct communication between the River Don, the Black Sea, and the Sea of Azov, and will also be the medium of connecting several South Russian railway lines. It will be of considerable strategical importance, but its commercial significance will be still greater, as it will enable coals to be brought from the rich mines in the vicinity of the River Don to the Black Sea, where their selling price will be lower than that of English coals, which, at present, are the only kind used at Constantinople and the Black Sea ports.

The Dynamo-Telephone.

Professor Silvanus Thompson has patented an idea which probably many electricians have thought over from time to time. This is the construction of magneto-telephones on the dynamo principle; that is to say, the generation of the telephonic currents in an armature moved by the voice in a magnetic field so as to cut the lines of force. The ordinary magneto-telephone may, in fact, be considered as a dynamo-telephone in which the lines of force are altered by the movement of the iron armature which is in the convenient form of a diaphragm directly vibrated by the voice. It may also be known to some of our readers that the suspended coil of the syphon recorder, which may be regarded as a vibratory armature coil in a magnetic field, serves as a telephone. Trials of it in this respect were made soon after the Bell telephone was introduced. Professor Thompson's apparatus, as set forth in the patent, consists of several forms of armature, one similar to the Gramme ring, and vibrated in the magnetic field by means of a proper attachment to a diaphragm vibrated under the action of the voice.

The late Sir Francis Bolton.

Colonel Sir Francis Bolton, who died last week at Bournemouth, where he had gone for the benefit of his health, was a man of distinction in the electrical profession as well as public analyst of the metropolitan water supply. He had served with honour in the army, chiefly on the west coast of Africa, and after his retirement to private life as an engineer and electrician he gained many friends and a successful business. The founder of the Society of Telegraph Engineers and Electricians, he took a great interest in that flourishing body, which has its rooms at his offices, 4, Broad Sanctuary. To the last he remained its honorary secretary. Some years ago Colonel Bolton published a pocket-book and calendar for the use of the electrical profession. He acquired more popular note, however, by his arrangement of the fountains at the recent South Kensington Exhibitions, and their illumination by means of coloured glass and the electric light. In these spectacular displays he took a great interest, and usually superintended their working in person. Sir Francis Bolton was much liked by those who came into contact with him; and his death will be greatly regretted by his more intimate friends.

An Indo-European Canal.

In a recent communication to the French Academy of Sciences, M. Emile Eude proposes a canal between India and Europe by way of the Euphrates Valley, the Persian Gulf, and Syria. This was in ancient times the great route of commerce, before the founding and development of Alexandria diverted it on Suez and led to the Suez Canal. The new route is put forward as a parallel way to that of Suez. His project is a canal with a double aim, a canal of irrigation and of navigation. In this way he proposes to restore fertility to these wastes. The plan is to create a river from Souëidieh to the Persian Gulf by making the Euphrates flow to the Mediterranean by Aleppo and Antioch; from Beles, in deepening the river from Beles to Felondjah (near ancient Babylon); in passing from the Euphrates to the Tigris by the canal of Saklavijah; and lastly, in descending the Tigris from Bagdad to Kornab, Bassora, and Fao on the Gulf. The new canal would shorten the going and coming voyage to Bombay by six days. M. Eude does not consider the engineering difficulties of a serious kind except the stony banks of Abou-Said and Kerbeleh, which, however, would not resist modern appliances. He estimates the total cost of the works at more than a milliard of francs, and the maximum capital required would be fifteen hundred million francs.

The Heating and Cooling of Cast Steel.

Barrett has shown, in the *Philosophical Magazine* (vol. xlvi., page 472), that if a bar of hard iron be allowed to cool from a white heat to dull redness, there is a spontaneous disengagement of heat, and its magnetic properties suddenly change. This phenomenon has been called *recalescence*; and M. Le Chatelier has also noticed that about 700 deg. C. there is a molecular modification of pure iron. In order, therefore, to see if recalescence is due to the heat set free by the modification of the iron, or if it requires the presence of carbon, M. Osmond has made a series of experiments which have been brought before the French Academy of Sciences. He operated with iron containing from 0.16 to 1.25 per cent. of carbon. He has found the existence of two phenomena of the kind observed by Barrett. The first is due to the molecular transformation of the iron, the second is evidently recalescence, and corresponds to a change in the relations of the iron with its carbon. It takes place at 675 deg. C., when the thermometer suddenly stops and then rises to 681 deg. C., afterwards resuming its regular fall as the metal cools. This was observed with steel containing 0.57 per cent. of carbon. With only 0.16 per cent. of carbon a much slighter effect of the kind was noticed about 749 deg. C.; this was probably due to the phenomenon noticed by M. Le Chatelier. With 1.25 per cent. of carbon the two effects appear to confound themselves. When the proportion of carbon is increased, the temperature of transformation of the iron seems to be lowered and the temperature of recalescence raised so that both come to coincide in hard steel. M. Osmond proposes by the same method to study the influence of impurities in steel.

The Longest Tunnel in the World.

An engineering work that has taken over a century to construct can hardly fail to offer some points of interest in its history, and illustrate the march of events during the years of its progress. An instance of this kind is to be found in a tunnel not long since completed, but which was commenced over a hundred years ago. This tunnel, or adit as it should be more strictly termed, is at Schemnitz, in Hungary. Its construction was agreed upon in 1782, the object being to carry off the water from the Schemnitz mines to the lowest part of the Gran Valley. The work is now complete, and according to the *Bauzeitung für Ungarn* it forms the longest tunnel in the world, being 10.27 miles long, or about one mile longer than St. Gothard, and 2½ miles longer than Mont Cenis. The height is 9 ft. 10 in. and the breadth 5 ft. 3 in. This tunnel, which has taken so long in making, has cost very nearly a million sterling, but the money appears to have been well spent; at least the present generation has no reason to grumble, for the saving from being able to do away with water-raising appliances amounts to 15,000*l*. a year. There is one further point, however, worth notice, for if we have the advantage of our great grandfathers in the matter of mechanical appliances, they certainly were better off in the price of labour. The original contract for the tunnel, made in 1782, was that it should be completed in thirty years and should cost 7*l*. per yard run. For eleven years the work was done at this price, but the French revolution enhanced the cost of labour and materials to such an extent that for thirty years little progress was made. For ten years following much progress was made and then the work dropped for twenty years more until the water threatened to drown the mines out altogether. Finally the tunnel was completed in 1878, the remaining part costing 22*l*. a yard, or more than three times as much as the original contract rate.

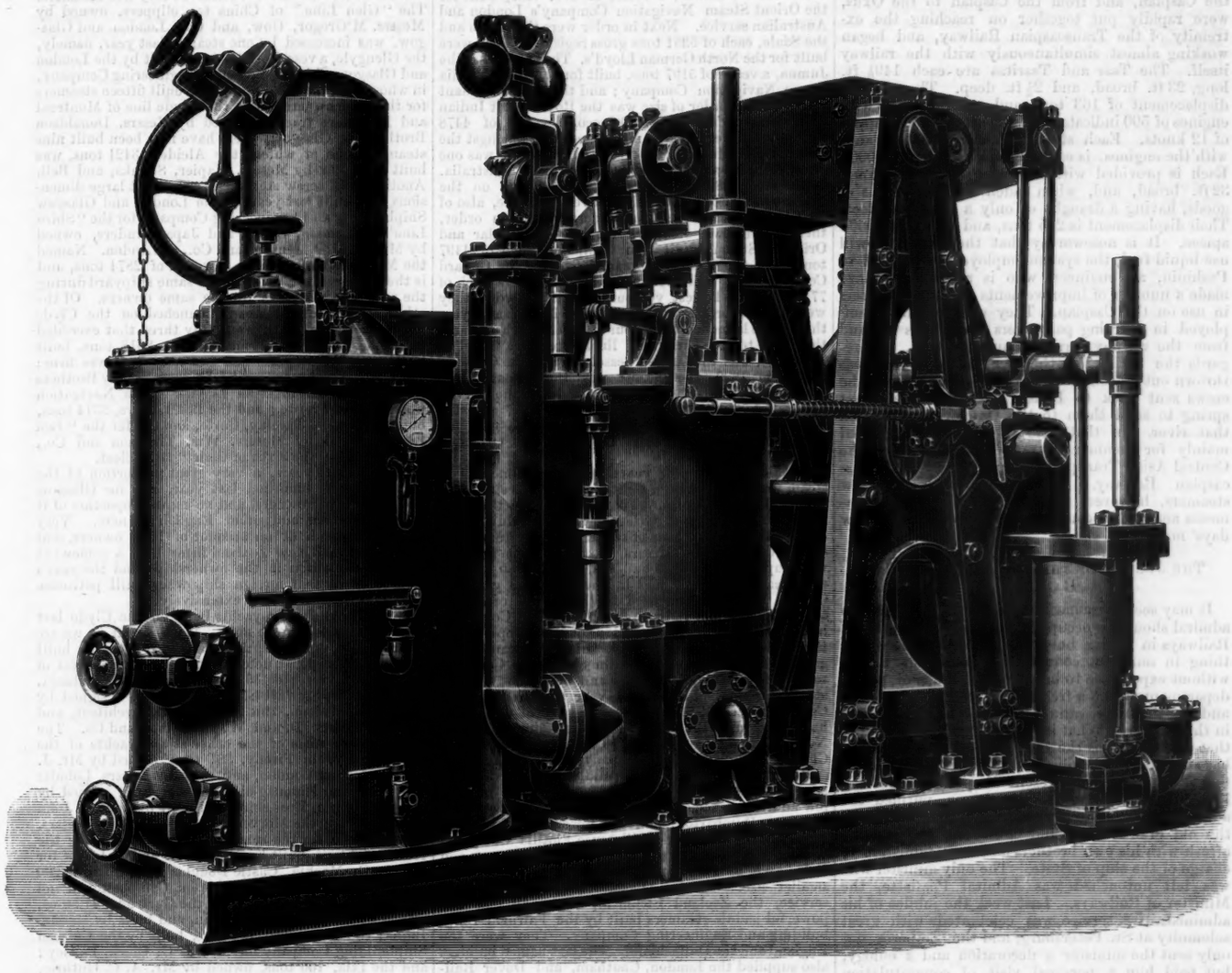
New Applications of Electricity.

We are so accustomed to the increasing use of electricity in nearly every phase wherein we live, move, and have our being, that but little notice is taken of these new applications until our notice

BEAM CALORIC ENGINE.

CONSTRUCTED BY THE PULSOMETER ENGINEERING COMPANY, ENGINEERS, LONDON.

(*For Description, see Page* 43.)



is called to some act so radically novel that it arrests attention. One of the first uses of the telephone was to summon physicians, and more or less definite hygeinic instructions have been given in reply, but the Atlantic cable has probably been the first to be used for the transmission of prescriptions and treatment for a patient. The cases in mind are American—perhaps naturally. A lady from New York, U.S., while travelling on the Continent, was taken ill of a fever in a German town, and her relatives being distrustful of the medical attendance, cabled every day to the family physician in New York, and received in turn detailed instructions both as to medicine and treatment. The case at one time became so serious that the home physician called in some of his colleagues for consultation. This treatment was kept up for several weeks, and the fair patient recovered and returned to her home early in October. The other case was that of the aged father of a millionaire merchant of New York, who was taken ill when in England, and bulletins of the patient's condition were daily cabled to family physicians at the office of his son in New York, and the results of the treatment, telegraphed in return, were of the most successful nature. Apart from the advantage which a family physician may possess, owing to a knowledge of physical habit and hereditary tendencies, there can be no marked difference in the therapeutic value of skilled medical attendance in any part of the civilised globe, but mentality exerts such a strong influence in disease, that a stranger in a strange land would undoubtedly feel an assurance of returning health by a knowledge that his treatment was prescribed by the skill of his trusted physician at home.

A Telephone Palace.

There are probably no capitals in Europe where the telephonic system has been brought into more general use than is the case in Stockholm, nor can any other town vie with the Swedish capital as regards perfection of arrangements, &c. The plan adopted there, as in most Swedish towns, is a high degree of centralisation, which simplifies the service and saves time and money. There are in Stockholm two independent companies, of which the Almänna Telephone Company seems to be taking the wind out of the sails of the Bell Company. The former has at present some 3600 subscribers, a large number for a moderately-sized town like Stockholm; and when its new building is completed there will only be two stations or centres, of which the new building will accommodate 3100 subscribers. The new building referred to has, not without cause, been christened a telephonic palace, as, with one or two minor exceptions, the whole of the large edifice, from cellar to top, is given up to the various departments of the company. The most interesting feature is undoubtedly the large telephone room, its length being 110 ft., with 30 ft. breadth, which obtains its light partly through the ceiling and partly through windows. It is at present intended for 4000 subscribers, but can be increased up to 7000 subscribers. These 4000 are divided among twenty tables, with 200 subscribers "proper" for each table, but according to the new and ingenious, although somewhat complicated, arrangements, all the other subscribers can "call on" each table, where the connection can then be established without communicating with other tables. There is also a special signalling system, which shows when a subscriber is engaged at another table. All this necessitates 16,000—and, should the service be extended to 7000, 28,000—connections at each table. The number of connections increases in proportion to the square of the number of subscribers, so that 7000 subscribers require forty-nine times as many connections as 1000. The staff of clerks in this room is two at each table, and, as there is a double set, the total is eighty clerks. The wires in the telephone room are arranged in net fashion, and the wires within the room will have the fabulous aggregate length of 160 Swedish miles.

The Russian Steamers on the Oxus.

The two Russian steamers which have been launched on the River Oxus during the last few days are not the first of the kind to traverse that classic stream, the steamer Samarcand, from the Syr Daria river, having demonstrated the navigability of the river from Kheva to the Afghan dominions some years ago. When the Russians began their wars with Bokhara and Khokand, twenty-five years ago, they formed a flotilla on the Syr Daria river, which, like the Oxus, runs into

the Sea of Aral. On that occasion the steamers had to be carried in sections on camel-back more than a thousand miles before reaching the dockyard at Kazala. On this occasion the steamers, after being carried the whole way in larger sections by steam, on river or rail from St. Petersburg to the Caspian, and from the Caspian to the Oxus, were rapidly put together on reaching the extremity of the Transcaspian Railway, and began working almost simultaneously with the railway itself. The Tsar and Tsaritza are each 149½ ft. long, 23 ft. broad, and 2½ ft. deep. They have a displacement of 163 tons and are provided with engines of 500 indicated horse-power, giving a speed of 12 knots. Each steamer is made of steel, and, with the engines, is computed to have cost 14,000*l*. Each is provided with a steel barge 165 ft. long, 32 ft. broad, and, when laden with 160 tons of goods, having a draught of only a couple of feet. Their displacement is 225 tons, and they cost 5000*l*. apiece. It is noteworthy that the steamers will use liquid fuel, the system employed being that of Pashinin, an engineer, who is reported to have made a number of improvements on the pulverisers in use on the Caspian. They will be chiefly employed in ferrying passengers and goods to and from the railway terminus and Bokhara. As regards the flotilla on the Syr Daria, which was thrown out of commission two years ago and the crews sent back to Russia, it is proposed next spring to send them to the Oxus for service on that river. In that case they will be employed mainly for commercial purposes, either by the Central Asian Transport Company or by the Transcaspian Railway. In common with the new steamers, however, they are provided with armaments and can be converted into gunboats at a few days' notice.

The Jubilee of the Russian Minister of Railways.

It may seem a remarkable circumstance that an admiral should be occupying the post of Minister of Railways in Russia, but, after all, it is the regular thing in our own country for politicians totally without experience to be appointed heads of public departments when a fresh party comes into office, and we, therefore, cannot fling a stone at autocracy in this matter. What is really more remarkable is that this admiral is the only Russian minister who has survived the Nihilist tempest that raged four or five years ago. The present Emperor, as is well known, when he came to the throne, purified the administrative atmosphere by shunting nearly all the old grand dukes and ministers, and starting afresh with his own brothers and new ministers in charge of the ship of State. The only minister who was left untouched was Admiral Possiette, the Minister of Railways. Last week the jubilee of his administrative service was celebrated with great solemnity at St. Petersburg, and the Emperor not only sent the minister a decoration and a eulogy, but paid him a personal visit of congratulation in the course of the day. General Possiette is the descendant of a Huguenot family that settled in Russia, and after considerable service at sea, during which he acted as commander of the Svietlana, the vessel that carried the Grand Duke Alcis (now head of the Russian Navy) round the world, he was appointed Minister of Railways in 1874. He has therefore been thirteen years in power, during which he has built 6000 miles of railway, deepened or started improving ten ports, constructed the sea canal at St. Petersburg, and excavated many hundred miles of canals. In Russia his title runs "Minister of Ways of Communication," an expressive comprehensive designation that includes not only the supervision of the railways, canals, and ports of the empire, but also the conservation of rivers and the management of the hundreds of thousands of miles of post roads that intersect the Czar's dominions from Prussia to the Pacific, and from the Arctic Sea to the Afghan frontier. Of course a proper supervision of all this cannot be expected, but it is well to bear in mind that a Russian minister can devote his whole time to his work, and does not require to expend nine-tenths in defending himself or attacking his political adversaries in Parliament or on the platform. General Possiette has made some mistakes, but in general he has been an honest, successful minister, and in all that appertains to engineering progress has displayed an amount of zeal, interest, and enterprise which English statesmen might do well to copy.

CLYDE SHIPBUILDING AND MARINE ENGINEERING IN 1886.

Second Article.

The vessels built on the Clyde last year were in several instances of considerable size. The largest of them was the Ormuz, a vessel of 6117 tons, built for the Orient Steam Navigation Company's London and Australian service. Next in order were the Trave and the Saale, each of 5381 tons gross register. They were built for the North German Lloyd's. Then there was the Jumna, a vessel of 5197 tons, built for the British India Steam Navigation Company; and the next merchant vessel in the order of size was the Royal West Indian Mail Company's steamer Orinoco, a vessel of 4478 tons. We have already mentioned that amongst the war vessels included in the year's output there was one of 5000 tons—namely, the belted cruiser Australia. In the year 1885 the largest vessel launched on the Clyde was a sister ship to the Trave and Saale, also of 5381 tons, and for the same owners. Next in order, there were two steamers for the Peninsular and Oriental Steam Navigation Company, each of 4497 tons. In the preceding year, however, the Cunard Company had built for them two steamers each of 7719 tons, the largest yet built on the Clyde; they were the Umbria and Etruria; and in the same year there were launched other four steamers each of more than 5000 tons. The Guion liner Oregon, a vessel of 7325 tons, was the largest vessel built on the Clyde in 1883; in 1882, the largest was the Cunard liner Aurania, a vessel of 7269 tons; in 1881, the Servia, a vessel of 7391 tons, and for the same line, was the largest; in 1880, the Persian, 5500 tons, was the largest; and the largest in 1879 was the Orient, a vessel of 5396 tons.

Within the past few years very large amounts of steam tonnage have been built for several well-known shipowning companies. For example, in the year 1882, the Clan Line, of Glasgow, received additions to the extent of 24,167 tons of steam shipping from Clyde shipyards; in 1883, Messrs. Donald Currie and Co. were supplied, by Clyde builders, with 21,980 tons of new steam shipping; and in the following year the Cunard Line was increased to the extent of 16,876 tons. The British India Steam Navigation Company, in the year 1885, took 10,051 tons of new shipping from the Clyde; the Peninsular and Oriental Steam Navigation Company and the Ocean Steamship Company took, respectively, 8993 tons and 5699 tons of new steam shipping. In the past year the British India Company were again the largest patrons of the Clyde, having taken 11,191 tons; they were followed by the North German Lloyd's, with 10,762 tons, and by the China Steam Navigation Company, with 10,569 tons.

Reverting briefly to the paddle steamer tonnage launched last year on the Clyde, we may here make a few additional remarks. Messrs. William Denny and Brothers, Dumbarton, built no fewer than five such vessels, all of steel, for La Plateuse Flotilla Company, of Buenos Ayres. Two of them were the Venus and Eola, each of 1749 tons. The others were of much smaller size. For the Queensborough and Flushing service, the Zeeland Steamship Company had two powerful paddle steamers built by the Fairfield Shipbuilding and Engineering Company. They were the England and the Duitschland. The last-named builders also supplied the London, Chatham, and Dover Railway Company with the paddle steamer Victoria, a vessel of 940 tons, for the Channel service. Two steel paddle steamers, the Beeloo and the Dufferin, each 1033 tons, were built by Messrs. William Denny and Brothers for the Irrawaddy Flotilla Company of Rangoon. There were also built during the year paddle steamers for Melbourne, and for Auckland, New Zealand, in addition to which two stern-wheel steamers were built by the Fairfield Company for Messrs. Cook and Sons' Nile excursion service. The year's output also included two saloon paddle steamers for passenger service on the Clyde, a tug steamer of 150 tons for the Glasgow and Greenock Shipping Company, a tug of 120 tons for the Irvine Harbour Commissioners, a small paddle steamer for the African Lakes Company, and a paddle passenger steamer for a Penang firm.

As already mentioned, the British India Steam Navigation Company last year took 11,191 tons of new shipping from the Clyde, thus placing them in the first position, which they also held in the preceding year. This is the seventh time during the past fourteen years that the same company have been the largest patrons of the Clyde shipbuilding trade. It is specially worthy of remark that since the year 1860 the company's fleet has received 107 steamers, of a total of 191,200 tons, of Clyde built shipping, and it is probable that the total value of those vessels would amount to upwards of three and a half millions sterling. One of the vessels added to the fleet last year was the Jumna, already mentioned, and the others were the Putiala and the Pulitana, both of steel, of 2997 tons each, and built by Messrs. A. and J. Inglis. In passing, it may be mentioned that the Trave and Saale make a total of thirty-nine vessels built for the North German Lloyd's Bremen and New York mail and passenger service since the year 1858. Five steel screw steamers were built during the year by Messrs. Scott and Co., of Greenock, for the China Steam Navigation Company, of London. Four of them were vessels of about 2270 tons each, and the other was somewhat smaller. During the past thirteen years there have been built at Greenock for the same owners twenty-five steamers. The "Glen Line" of China tea clippers, owned by Messrs. M'Gregor, Gow, and Co., London and Glasgow, was increased by one steamer last year, namely, the Glengyle, a vessel of 3455 tons, built by the London and Glasgow Shipbuilding and Engineering Company, in whose yard there have now been built fifteen steamers for the same owners. For the Clyde line of Montreal and Baltimore traders, owned by Messrs. Donaldson Brothers, of Glasgow, there have now been built nine steamers, one of which, the Alcides, 3421 tons, was built last year by Messrs. Napier, Shanks, and Bell. Another steel screw steamer of somewhat large dimensions was built last year by the London and Glasgow Shipbuilding and Engineering Company for the "Shire Line" of London, China, and Japan traders, owned by Messrs. D. J. Jenkins and Co., of London. Named the Monmouthshire, she is a vessel of 2874 tons, and is the ninth steamer built in the same shipyard during the past fourteen years by the same owners. Of the other steel screw steamers, launched on the Clyde during last year, there were only three that exceeded 2000 tons. They were the Bléville, 2518 tons, built by Messrs. A. Stephen and Sons, for a Havre firm; the Thalia, 3332 tons, built by Messrs. Denny Brothers for the Austro-Hungarian Lloyd's Steam Navigation Company, of Trieste; and the Ben Lawers, 2314 tons, built by Messrs. Barclay, Curle, and Co. for the "Ben Line," owned by Messrs. Wm. Thomson and Co., Leith, forming the sixth of their "Ben" fleet.

As in former years, a very great proportion of the steam tonnage, launched last year, was for Glasgow and other Clyde owners, and no mean proportion of it was for London and other English owners. Very little of it was built on account of Irish owners, but Australian and New Zealand firms hold a somewhat prominent position in the ownership; and the year's returns show that foreign shipowners still patronise the Clyde shipyards very extensively.

Several of the steam yachts built on the Clyde last year are vessels of some note. With, so far as we are aware, only one exception, last year's Clyde built yachts were all constructed of steel, and the largest of them was a vessel of 430 tons, to wit, the Vanduara, owned by Mr. Stewart Clark, of Paisley, designed by Mr. G. L. Watson, the famous naval architect, and built by Messrs. D. and W. Henderson and Co. The following are some of the other steam yachts of the year, namely, the Firefly, 381 tons, owned by Mr. J. W. Clayton, of London, and built by Messrs. Lobnitz and Co.; the Rionnag-al-Maru, 311 tons, owned by Mr. A. G. Pirie, Ross-shire, and built by Messrs. John Reid and Co.; the Morven, 233 tons, built by Messrs. Caird and Co. for the senior partner of that firm; the Ituna, 230 tons, built by Messrs. A. and J. Inglis for Mr. J. G. Mackie, Castle Douglas; the Oimaru, 200 tons, owned by Mr. Neil Mathieson, Campbeltown, and built by Messrs. Reid and Co.; the Gertrude, 112 tons, owned by Mr. T. Hayes, Dublin, and built by Messrs. Inglis; the Cassandra, 104 tons, built by the Culzean Shipbuilding Company for Mr. J. G. Clark, Paisley; and the Ixia, 100 tons, owned by Mr. A. C. Guthrie, Duart Mull, and built by Messrs. Barclay, Curle, and Co.

Tug steamers are now built in greater numbers on the Clyde than was formerly the case, such a thing as a tug being built on the Tyne for Clyde owners seems now to have become a thing of the past. The Clyde now builds such vessels, not only for the local towing fleets, but also for various other home and foreign ports. Of the tug steamers built on the Clyde in 1886, no fewer than three were of the twin-screw type, and they were all built by Messrs. Robert Duncan and Co., Port-Glasgow. Two of them, the Flying Dragon and Flying Serpent, were vessels of 261 tons, each having engines of 622 indicated horse-power, and they were both built for the Clyde Shipping Company. The third, named the Warren Hastings, is a vessel of 618 tons, with engines of 1602 horse-power. She was built for the Clive Towing Company, of Calcutta, and is certainly one of the most powerful tug steamers afloat.

The steam dredging plant, which was launched last year, was built exclusively by two firms, namely, Messrs. William Simons and Co., Renfrew, and Messrs. Fleming and Ferguson, Paisley, both of which have acquired well-earned reputations for such plant. The first-named firm launched the Dolphin, hopper dredger, a vessel of 249 tons, with engines of 300 horse-power, for Colonial Crown agents, and a double-twin screw hopper dredger of 1049 tons, with engines of 1300 horse-power, for the Corporation of Bristol. Messrs. Fleming and Ferguson also launched two dredgers during the year, namely, the Gilbertson and the Walter Bibby, both vessels of 600 tons, with engines of 120 horse-power nominal, and both for the corporation of Preston, to be used in the improvement of the navigation of the River Ribble.

As regards the sailing vessels launched last year, there are a few facts which it may be interesting to refer to. The total tonnage of this class of vessels was considerably under the amount included in the total output from the Clyde shipyards in the year 1885. Last year the output of sailing vessels amounted to 65,912 tons, whereas in the preceding year sailing vessels represented 104,465 tons. The number of new vessels in this class launched during the past two years was respectively, 44 in 1886, and 72 in 1885. It is specially interesting to note that there has been, relatively, a material increase in the amount of sailing tonnage built of steel during the past year, for whereas the iron-built sailing ships amounted to 55 in 1885, they numbered only 26 in the past year, while the number of steel-built sailing vessels was the same in both years.

Many of the sailing vessels were of very considerable size, one of them being rated at 2457 tons, and her sister ship at 1 ton less. These were the Perseverance and Tarapaca, both iron built, both owned by Messrs. A. D. Bordes and Co., Bordeaux, and built by Mr. W. B. Thompson. The greatest amount of the kind of shipping built last year for any single firm, was that supplied to Messrs. P. Denniston and Co., Glasgow, for whom there were built three sailing vessels of a total of 5675 tons for their fleet of Clyde and Australian traders. In the preceding year the same firm added four such vessels to their fleet, of a total of 6168 tons, which was the largest amount of this kind of shipping built in one year for one firm for many years back. For Messrs. Wright and Breakenridge, of Glasgow, Messrs. Russell and Co. built two very large iron sailing vessels, the Falls of Garry, 2088 tons, and the Falls of Halladale, 2080 tons. For the "Burn" line of sailing traders, owned by Messrs. Shankland and Co., of Greenock, there were built two very fine steel ships, the Bannockburn, 2068 tons, by Messrs. Barclay, Curle, and Co., and the Gowanburn, 2079 tons, by Messrs. Scott and Co. For the "River" line of Messrs. James Nourse and Co., London, Messrs. Russell and Co. built the Erne, 1692 tons, and the Rhine, 1694 tons. The "Port" line owned by Messrs. Crawford and Rowatt, Glasgow, had two additions, the Port Yarrock, 1379 tons, and Port Ramsay, 1375 tons, also built by Messrs. Russell and Co. The "County" line owned by Messrs. R. and J. Craig, Glasgow, had one addition, the County of Roxburgh, 2209 tons, built by Messrs. Barclay, Curle, and Co. Messrs. Connell and Co. built a sailing vessel of 2204 tons, named the Earl of Aberdeen, for Messrs. D. Brown and Son, Liverpool. For Messrs. W. R. Price and Co., London, Messrs. A. M'Millan and Sons built a steel sailing ship, of 2311 tons, named the Lyndhurst. Similar vessels, some of iron and some of steel, were built for various other shipowning firms, Scotch, English, and foreign; several of them also exceeded 2000 tons, and many of the others ranged between 1800 tons and 1200 tons. The greater proportion of these sailing ships were of the four-masted type, which is now very popular on the Clyde, which is, if we mistake not, the place of its origin and development. Five of the large sailing ships, all exceeding 2000 tons, which were built by Messrs. Russell and Co., were of this type. The same is also true of the Gowanburn, the Bannockburn, the County of Roxburgh, and other sailing ships included in last year's output from the Clyde shipyards. Such ships are said to be much more economically handled than three-masted ships of similar dimensions.

There are still a number of firms on the Clyde whose work is exclusively that of shipbuilding, amongst which we may name Messrs. Russell and Co., Messrs. Robert Duncan and Co., Messrs. M'Millan and Sons, Messrs. Connell and Co., Messrs. Napier, Shanks, and Bell, and others. In the case of the first-named firm, the work hitherto done has been almost wholly the building of sailing ships, in the construction and equipment of which they have attained a high degree of excellence. Last year, as indicated in our first article, their output of new shipping was entirely of the kind referred to; at the same time, not one of the seventeen sailing ships turned out by the firm was built of steel. A very high reputation in the building of this kind of shipping is likewise possessed by Messrs. Duncan and Co., by Messrs. M'Millan and Sons, and by two or three of the Whiteinch firms.

BEAM CALORIC ENGINE.

CALORIC engines have long been used by the Trinity Board to provide power for working siren fog signals in connection with their lighthouses. They have generally been in the past of the horizontal type, but lately a new pattern, which we illustrate on page 41, has been brought out, and as the entire work of the motor consists in driving air-compressing pumps, this form of engine should give very good results. At one end of a beam stands the retort or furnace with the motor cylinder, and at the other end stand three pumps. One of these forces air into the furnace, a second supplies the receiver of the fog signal, while the third, which is smaller than the second, performs the same office, when it is desired to raise the pressure to a point too high for the larger pump to accomplish. As fogs come on very suddenly, and give so little warning that it is often impossible to get the engine into action before the vision is entirely obscured, it is customary to keep a store of air in the receiver at two or three times the usual working pressure, and it is from the accumulation of this pressure that the smaller pump is provided.

The furnace is a closed receiver and is fed with coke. Air is pumped into it at a pressure of about 30 lb. to the square inch, part being delivered below the fuel and part above. That part which goes below rises through the incandescent coke, and appears at the surface as carbonic oxide. Here it meets the upper air supply and burns with a fierce bright flame, producing very hot gases which are admitted to the cylinder and there expand, driving the piston before them. From experiments made by Mr. C. Ingrey, of Albert Buildings, Queen Victoria-street, with engines of this kind, it appears that they consume from 2¼ lb. to 2½ lb. of coke per brake horse-power per hour, and thus provide power very economically.

The engine is regulated by a governor, which varies the proportion of air admitted above and below the fuel, and thus alters the temperature of the gases admitted to the cylinder. The distributing valves are of the conical type worked by tappets, and the fall is regulated by an air cushion.

These engines, for there are a pair, have been constructed by the Pulsometer Engineering Company, Limited, of Nine Elms, London, for the Northern Lights Commissioners, and will be erected on a light-ship, probably at the North Carr. Each engine is nominally of 6 horse-power, but actually gives 10 horse-power. The motor cylinder is 24 in. in diameter, the air-pump 18 in., and the compressing pumps 9 in. and 5 in. respectively, all with a stroke of 18 in.

BURNETT'S ROLLER WEDGE.—Burnett's roller wedge, of which we gave an account in our issue of September 24, has been tried by a committee appointed by the Mining Institute of Scotland with most satisfactory results. The round coal produced on an average of twenty-two experiments in three different seams, amounted to 79¼ per cent.

SWANWICK SEWAGE FARM.—A small farm of 15 acres is now being laid out for sewage irrigation near Butterley reservoir. The land is a stiff clay, but it is being specially prepared and lightened to a considerable depth with fine ashes, and close drained. It is believed by the method adopted the strongest clay land may be made suitable for the reception of sewage; and thus one of the great difficulties in the way of sewage purification in some districts will be removed. The farm will receive the sewage from a population of nearly 4000. Mr. W. H. Radford, sanitary engineer, Nottingham, is the engineer for the works.

NEWHAVEN DRAINAGE.—The tender of Mr. James Haywood, contractor, Eastbourne, was last week accepted by the Newhaven Local Board for the construction of a complete system of sewerage with outfall sewer and storage culvert. The sewage will be delivered during the ebb tide in the River Ouse, at the mouth of the harbour, and close to the sea. The amount of the contract is 5557*l*. The scheme has been approved by the Local Government Board and the Harbour Company, and negotiations with the War Department and Board of Trade are approaching completion. The engineer to the works is Mr. W. H. Radford, Assoc. M. Inst. C.E., Nottingham, and the scheme was selected from more than twenty designs in open competition.

THE INSTITUTION OF CIVIL ENGINEERS.—At the ordinary meeting on Tuesday, January 11, Mr. Edward Woods (President) in the chair, it was announced that Robert Wilson, associate member, had been transferred to the class of members. At the same meeting it was reported that the following twenty-eight candidates had been admitted as students, viz.: George Herbert Abbott, Edward Goulden Boden, Walter William Booth, Walter Bosman, Frank Conington, William Horace Coomber, Thomas Burnside Crowther, Edward Downes Dupré, Guy Ellington, William Dixon Fisher, Robert Gelston, Frederick William Godfrey, Frederick Henry Grimshaw, Herbert Ross Hooper, B.A., Herbert Alfred Humphrey, James Skidmore Jones, Frederick William Antony Knight, Henry John Lawson, David Lyell, Donald Marsh McClure, William MacGlashan, John Chapman Mount, Robert Richardson Richmond, John Edwin Rogerson, B.A., Lindsay Scrutton, Edward Stocklay Sinnott, Frederick James Wellington Vereker, and Walter Wilson. The monthly ballot resulted in the election of four members, viz.: Charles Christison Bone, Daniel Macnee, Julius Pazzani, and Thomas Richards; and of eighteen associate members, viz.: James Barratt, Hugh Walter Belcher, B.A., Stud. Inst. C.E., Charles Brownridge, Stud. Inst. C.E., Henry Slade Childe, Edward Claude Hawkes, William Wykeham Jacomb, Stud. Inst. C.E., Robert Lyell, B.Sc., Stud. Inst. C.E., Arthur Robert Penny, Herbert Arthur Phillips, William Arthur Price, M.A., George Richard Richardson, Stud. Inst. C.E., Walter Howard Tate, Reginald Arthur Tatton, William Edmund Clason Thomas, Joseph William de Tivoli, Harold Sebastian Vogan, Stud. Inst. C.E., George Powell Walker, Stud. Inst. C.E., and Henry Buckler Warren.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market was much excited last Thursday, and prices were very irregular, in fact the market was under the influence of an upward "boom." At one time the quotations were 8½d. up, again 9d. down, and the close was 2½d. per ton over that of the previous day. The top price in the forenoon was 46s. 7½d. cash. There was a sudden drop in the afternoon, followed by a recovery to 46s. 2d. at the close. Up to 37s. cash was paid for Cleveland warrants, and 48s. cash for hematite warrants, but the closing quotations were lower in both cases. The buoyancy of the market was not nearly so great on Friday, but a considerable amount of excitement was again manifested, and some holders showed a tendency to realise, which had a depressing effect. When any smart reduction took place, however, buyers were found, and prices partially rose again. The closing prices showed a fall of 4d. per ton from Thursday's close, and 10d. from the highest quotation that day. Over the week the fluctuations amounted to 1s. 9d. per ton, representing a sum of 73,500*l*. on the stock in the public warrant stores, and of 30,000*l*. on the pig iron in the makers' yards. There was another "boom" in the market on Monday, and prices not only recovered the decline registered at the close of last week, but went up to 3½d. above last week's highest quotation, and reached the highest rate paid for warrant iron since the year 1883. The close was 46s. 9d. cash, being a gain of 1s. per ton on the day, or 25*l*. on each warrant, and 2500*l*. per hundred warrants. On the stock held by the iron brokers and the general public in Messrs. Connal and Co.'s warrant stores, the advance on the day was equal to a sum of 42,000*l*., and on makers' stocks it was equal to a sum of 17,200*l*.—in all, an increase in the value of the stocks to the extent of fully 59,000*l*. Monday, highest quotation—46s. 11d. cash—was 9s. above last year's lowest quotation, representing to makers, brokers, merchants, and other holders an increase in the value of their stock of iron to the extent of 531,000*l*.; but about two-thirds of the increase has taken place within the past two months. From January 4 up till last Monday there was an advance in the price of Scotch pig iron equal to 2s. 3d. per ton, and in the price of Cleveland and hematite warrants equal, respectively, to 2s. 3d. and 2s. 2d. per ton. The market was less firm yesterday, and prices lost 1½d. on the previous day's gain. There were fluctuations to the extent of 6d. per ton. Business opened in the forenoon at 1d. over Monday's closing quotations, at 46s. 10½d. cash, thence prices declined to 46s. 5½d., but recovered to 46s. 7d. cash, and at one month prices went from 47s. to 46s. 9d., the close being buyers at 46s. 6d. cash and 46s. 9½d. one month, with sellers asking 1d. per ton higher. There were considerable realisations by holders during the forenoon market. Business was done in the afternoon at 46s. 7½d. down to 46s. 4½d. and back to 46s. 7½d. cash, also at 46s. 9d. to 46s. 8d. and up to 46s. 11d. one month, with buyers at the close at 46s. 7½d. cash and 46s. 10½d. one month, and sellers at ½d. per ton more. There were transactions this forenoon at 46s. 11d. to 47s. 7d. cash, and up to 47s. 10½d. one month, sellers at the close wanting ½d. per ton higher. In the afternoon the quotations declined to 47s. 2d. cash and 47s. 4½d. one month, which were the closing rates for buyers, sellers wanting ½d. per ton higher. While the business done in warrants during some days past, has no doubt been chiefly confined to members of the trade, yet there has been considerably more done for the outside investors than for some time past. Much of the recent advance in prices is said to be traceable to strong advices received from the United States by mail and cable as to the position of the iron and steel trades there, and to the great probability that they will make increased demands on us for supplies of raw material. It is stated that the December returns of the Cleveland iron trade have also favourably helped to stiffen the markets. Shipping brands are all firm in price, and a considerable advance has been made in some instances—in the case of Carron "selected" pigs to the extent of 2s. per ton, and 1s. per ton on the lower grades. There were still 75 blast furnaces in operation at the end of last week, as compared with 92 at the same time last year; but it is reported this week that the Coltness Iron Company have just blown in another furnace, thus making nine in blast out of the twelve erected. Last week's shipments of pig iron from all Scotch ports amounted to 7557 tons, as compared with 6332 tons in the preceding week, and 5598 tons in the corresponding week of last year. The United States took 1150 tons; India, 150 tons; Australia, &c., 235 tons; France, 150 tons; Italy, 2583 tons; Germany, 600 tons; and other countries took smaller quantities. The stocks of pig iron in Messrs. Connal and Co.'s public warrant stores have again begun to increase to some extent.

Royal Scottish Society of Arts.—The third meeting of the session of the Royal Scottish Society of Arts took place on Monday night, Mr. D. Bruce Peebles, F.R.S.E., President, in the chair. There was a good attendance of members. A paper was read by Mr. William Bennett, governor of the City Poorhouse, Craiglockhart, on "Improvements in Apparatus for Bunching Firewood," which was illustrated by photographs and by the machine in action. Mr. Bennett claimed for his machine greater simplicity, efficiency, and economy of labour than the machines now in use. It is worked on the screw principle, which is said to be an improvement on the lever bunches in general use. At the firewood factory of the City Poorhouse the pressure of work and the want of men of sufficient strength to work the ordinary lever led Mr. Bennett to work out the invention under notice, with the result that an old man seventy-five years of age, who was unable to work the ordinary lever, turned out 230 bundles of firewood in three and a half hours. The screw is made

of tempered steel, and the power is thrown on the apparatus rather than on the operator. The illustrations of the working of the machine were of a highly successful nature, and at the close a cordial vote of thanks was given to the lecturer for his paper. In the discussion to which the paper gave rise, it was suggested to the inventor that he should further perfect the machine by making it tie up the bundle also. In connection with some remarks in Mr. Pollitt's paper on the "Mirror Level," Dr. Sang, secretary, showed, by means of the microscope, the motions of fluids in the cavities of Iceland spar.

Advance of Wages to Blast Furnacemen.—The directors of the Shotts Iron Company have just sanctioned an advance of wages to the workmen connected with the blast furnaces at Shotts, to the extent of 10 per cent. on tonnage rates, and 6d. per day on shift wages. This advance of wages is regarded as a good indication of the improvement now in progress in the iron trade.

The Gas Meter Trade in Edinburgh.—The gas meter trade of Edinburgh, which is now a most important branch of skilled industry in that city, is considered to be in a most satisfactory condition at the present time. In the meter-testing department during the five months ending December 31 last, 21,038 meters were tested, on account of which fees were received to the amount of 705*l.* 6s., being an increase of 139*l.* 3s. 6d. on the receipts during the corresponding period of 1885. Of the number tested, 11,544 were wet meters and 9495 were of the dry sort. During the month of December alone 4929 meters were tested, the fees amounting to 174*l.* 19s. 6d. That is the greatest monthly return since the Act was adopted in the year 1861, it being 75 per cent. above the average.

Gourock Railway Works.—The works involved in the extension of the Caledonian Railway from Greenock to Gourock are progressing rapidly. The piling for the pier at Gourock, which was only to have extended eastward as far as the old pier, is now to be continued about 100 yards further. Owing to the very soft nature of the ground, piles of even 90 ft. in length scarcely reach a firm bottom. It is probable that the pier will be ready in time for the river passenger traffic next summer. There is now a new project spoken of in connection with the pier, which is the landing of cattle by an under stage.

Processes of Refrigeration.—The first special afternoon meeting of the Royal Society of Edinburgh was held last Friday—Professor Sir Douglas Maclagan, vice-president, in the chair—when an address on "Processes of Refrigeration" was given by Mr. J. J. Coleman, of Glasgow. The evaporation of ether, said Mr. Coleman, had been a favourite medium of refrigeration for many years, but recently ammonia machines had come into favour. There were two descriptions of these—one called the ammonia-absorption machine, which was independent of a steam engine; and the other, in which ammonia gas was compressed by the aid of a steam engine. Such machines were used principally for ice-making, compressed air machinery being employed entirely on board ship for the conveyance of frozen meat. Mr. Coleman then described the first machine which brought meat from the antipodes in a frozen condition, and said these machines had brought several thousand carcases of sheep to London in 1882 in a frozen state. Since that time they had become very largely used, almost all vessels trading with New Zealand being fitted with them, as well as a large number of steamers trading with the River Plate. Mr. Coleman concluded by explaining the experiments made by himself and Professor M'Kendrick jointly on the influence of cold on micro-oganisms, by which it had been proved that these germs, although rendered torpid and inactive when in a frozen state, were not deprived of life, but regained activity even after an exposure of [a 100 hours to a temperature of 120 deg. Fahr. below zero. On the motion of Professor Crum Brown, a vote of thanks was awarded to Mr. Coleman.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Chesterfield and Midland Counties Institution of Mining Engineers.—A general meeting of the members of this Institution was held on Saturday, at the University College, Nottingham. In the absence, through illness, of the President, Lord Edward Cavendish, M.P., the chair was taken by Mr. John Jackson, Clay Cross. A number of new members were admitted. Mr. A. H. Stokes's papers, "Notes upon the Reports of the Royal Commissioners on Accidents in Mines," and "Notes upon Safety Lamp Experiments," came before the meeting for discussion. Mr. G. E. Smith (Nottingham) exhibited a new electric miner's safety lamp, invented by Mr. Pilkins, of London. The lamp possessed a secondary battery in distinction from that which had previously been shown. That with the secondary battery could only be used, it was explained, in mines where the electric light was used, as it needed charging from the dynamo. Mr. Morgan, of Pontypridd, again attended with his apparatus for testing miners' safety lamps. Mr. Stokes took objection to the apparatus on the ground that it did not fairly represent the conditions likely to prevail in a mine. Mr. Morgan gave instances of "blowers" in which these conditions would be fulfilled; and both he and Mr. Mawer defended the Morgan lamp as the safest in the market. A discussion took place as to the advantage or otherwise of the various bonnetting of lamps, some members arguing that the bonnets shown in some instances had the disadvantage of being so constructed that it was possible by mistake to send the lamps into the pit without the gauze, an omission which, as Mr. Stokes said, would convert them into mere death-traps; but Mr. Ashworth, whose lamp was amongst those shown, took it to pieces, and demonstrated the improbability of such a contingency. In the course of a further conversation, Mr. Lewis, replying to the observations made by the chairman at the beginning of the meeting, urged that if the use of safety lamps in all pits were made compulsory, even more accidents would happen than was the case at present, since there would be less chance of detecting places in which the roof was likely to fall.

South Yorkshire Coal Traffic.—The annual return showing the quantity of coal sent from this district to London last year, shows a gigantic trade. Messrs. Newton, Chambers, and Co. (Limited), sent 343,831 tons; the Clay Cross Company, 283,435 tons; Blackwall Colliery Company, 191,399 tons; Langley Mill Colliery, 187,269 tons; Grassmore Colliery, 168,291 tons; Sheffield Coal Company, 161,625 tons; J. and G. Wells (Limited), 157,939 tons; the Linley Colliery, 154,978 tons, and Aberdare Colliery, 151,286 tons. The quantity of coal sent from South Yorkshire to Hull last year was 1,418,000 tons, nearly 90,000 tons over 1885.

Increase in the Iron and Steel Trade.—During the present week there has been a marked increase in the number of orders which have come in for all classes of manufactured iron and steel, particularly in the rail department. As a result, there is a rise of from 2s. to 4s. per ton in the price of Bessemer steel, and hematite irons are dearer than last week by 6d. to 1s. per ton. At the foundries, also, there is considerably more doing, especially where heavy steel castings are a speciality. This impetus was scarcely expected, as the opening week of the year was almost void of important inquiries.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Last week's shipments of coal from Cardiff comprised 120,000 tons. Patent fuel was also shipped to the extent of upwards of 3000 tons. The coal trade is considered to be acquiring a healthier tone, and steam coal of the best quality has been a shade firmer at 8s. 3d. to 8s. 6d. per ton. House coal has also been in good demand. As regards the iron and steel trades, it may be added, that the works have been pretty well employed, and that prices show a firmer tendency.

The Somersetshire Coast.—It is reported that the Midland and the London and South-Western Railway Companies contemplate the provision of extensive dock accommodation at the estuary of the Parrett, near Bridgewater, and at a point where the Somerset and Dorset line, jointly worked by the two companies, has a terminus.

Death of Mr. Bage.—Mr. W. Bage died on Saturday at his residence, Tredegar Lodge, Cardiff. In his younger days, Mr. Bage was employed in connection with the construction of the Taff Vale Railway. He afterwards fulfilled engagements in Hungary, Sweden, &c. When a Royal Commision was appointed to investigate the position of Irish railways, with a view to their purchase by the State, Mr. Bage was one of the civil engineers selected to advise the commission. In the closing years of his life, Mr. Bage settled at Cardiff, where he became a director of the Penarth Shipbuilding Company.

Water Supply of Bristol.—On Friday the Bristol Town Council discussed at considerable length the question of the water supply of the city. It was resolved that support should, conditionally, be given to a Bill promoted by a new water company, formed for the purpose of utilising Sudbrook springs. It was also decided that it was desirable that the council, on behalf of the rate payers, should have absolute control of the water supply. It was, therefore, agreed that the council should approach the existing company with a view to the purchase, at a reasonable price, of their rights and interests. If the council can carry out such an arrangement, it will, having also acquired the rights which the new company is prepared to sell to it, be in a position to supply Bristolians at a reduced cost, with an unlimited supply of pure water.

Gas at Merthyr.—At a meeting of the Merthyr Local Board, on Wednesday, a committee appointed to go into the matter reported that they had dealt with the accounts of the Merthyr Gas Company for 1883, 1884, and 1885; and having considered the same and the profits made, they had directed the clerk to write to the company asking the terms upon which they would be prepared to sell their works and plant to the Board.

Devonport.—There are rumours at Devonport Dockyard of an intended further discharge of men. The reduction will not, it is stated, be made in the constructive department, but in the steam branch of the dockyard at Keyham. Should the discharge take place, about 100 men selected from the various branches of the trade will receive notice. It is probable, however, that repairs to the Northumberland, the Dragon, and the Curaçoa may prevent the discharge taking place, at any rate for the present.

Bristol and the Channel Islands.—A line of steamers (of which Messrs. Baker and Butt are the agents) is to be run between Bristol and the Channel Islands.

The Tin-Plate Trade.—Arrangements are being made for restarting the works of the Pontypool Iron and Tin-Plate Company at Pontypool, Pontnewynydd, and Pontymoile. When fully employed, these works are sufficiently extensive to occupy 1000 workpeople.

Bristol Tramways.—It appears that at the close of June, 1886, the expenditure made by the Bristol Tramways Company on capital account was as follows: On lines and works open for traffic including land, buildings, &c., 124,684*l.*; on houses, 11,220*l.*; on cars, 12,000*l.*; legal and parliamentary, 11,116*l.*; and miscellaneous, 9561*l.*; total, 168,581*l.* The length of tramway authorised, exclusive of expired powers, was: Double line, 4 miles 65 chains; single line, 6 miles 50 chains; total, 11 miles 35 chains. The length of line open for public conveyance was: Double line, 4 miles 62 chains; single line, 6 miles 20 chains; total, 11 miles 2 chains. The total revenue acquired for the year ending June 30, 1886, was 38,991*l.*, the working expenses of the year having been 31,253*l.*, the net profit realised was 7738*l.* The aggregate number of passengers conveyed during the year, including season and composition ticket holders, was 5,457,271; and the aggregate distance run was 737,673 miles. The working stock consists of 374 horses and 70 cars.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

Quarterly Meeting of the Cleveland Iron Trade.—Yesterday the quarterly meeting of the North of England iron and allied trades was held in the Royal Exchange, Middlesbrough, and was well attended. As usual facilities were given for the exhibition of articles of interest to the trade, but only one or two agents availed themselves of this method of advertising. The market was strong and there was a vigorous inquiry for No. 3 Cleveland pig iron for early shipment at 37s. to 37s. 6d. per ton. For future delivery still higher prices were asked. Makers were most unwilling sellers, as they anticipated a firmer market. In this policy they were encouraged, as before the close of the market it was reported that the blast furnacemen had agreed to the proposals of the Cleveland Ironmasters, and had adopted a sliding scale for the regulation of wages for the next eighteen months. The favourable Board of Trade returns so far as iron and steel are concerned, and the satisfactory reports as to the American and Continental demand, have imparted renewed confidence to makers. Later on still more encouraging reports as to the American trade were received. Hematite pig iron was in full request at advancing prices, Nos. 1, 2, and 3 f.o.b. east coast ports being 47s. 6d. to 48s. per ton. The material rise in the prices of ore at Bilbao during the past few days has strengthened the hematite pig iron market. In the manufactured iron trade there is a steady volume of business and prices are firmer, in sympathy with the advance in raw materials. Ship-plates are quoted 4*l.* 15s. per ton, angles 4*l.* 7s. 6d. to 4*l.* 10s., steel ship-plates 6*l.* 5s. to 6*l.* 10s., and angles 5*l.* 15s. to 6*l.*, all less 2½ per cent. at works.

The Cleveland Blast Furnacemen's Wages.—The blast furnacemen have wisely agreed to the sliding scale for the regulation of their wages for the next eighteen months, as proposed by the Cleveland Ironmasters. The conference between employers and workmen's delegates was held at Middlesbrough on Tuesday, and the sliding scale was agreed to and signed. Since June, 1885, there has been no scale in existence, and the consequence has been that the men's wages have, since April, 1886, been below what were paid under the scales which regulated wages between 1879 and 1885. Under the arrangement now come to, the scale is renewed with some slight modifications, and in addition to what the scale gives, the men are to receive over the ensuing nine months the respective amounts taken off since April last in excess of the scale price. The blastfurnacemen's wages will in future be regulated by fractions somewhat after the manner of the wages at the Cleveland ironstone mines. Under this system the price of iron and the wages are kept more closely together than when the scale moves by steps of 1½ to 2½ per cent. There will be a movement in wages of .25 of 1 per cent. for each 2.4d. in the price of pig. Something like twenty of the blast furnace works in the North of England are affected by the arrangement now made. It would be well if the various trade unions were to federate and submit their labour questions to the Board of Arbitration for the North of England, which could easily be reconstructed so as to comprehend the whole of the iron and allied industries and deal with all questions affecting them as it has done for so many years in the manufactured iron trade.

Engineering and Shipbuilding.—Engineers and shipbuilders are getting busier.

The Coal and Coke Trades.—The coal trade is steady, but prices of coke are hardening. During the past few days coke has advanced about 6d. to 9d. per ton. It is hoped that the wages question in the Northumberland coal trade will yet be settled without stoppage of work at the collieries.

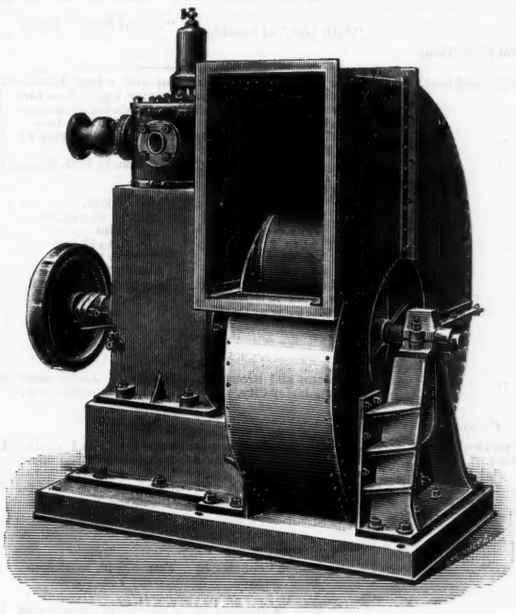
SHIPBUILDING ON THE WEAR.—The depression in the shipping trade has told heavily against the output of steamers built on the Wear for the past two years. The totals for the past six years are as under:

Year.	Number of Vessels.	Gross Tonnage.	Nominal Horse-Power.
1881	90	154,932	14,953
1882	123	212,434	19,520
1883	126	212,213	20,340
1884	70	99,424	8,370
1885	46	61,768	4,896
1886	39	56,450	5,750

The largest amount of tonnage last year was built by Messrs. J. L. Thompson, who turned out eight vessels, with a tonnage of 16,058 tons and of 1830 horse-power. Many of the vessels turned out were of steel, there being fourteen steamers of this description and five, at least, have been iron sailers.

COMBINED CHANDLER'S ENGINE AND FAN.

CONSTRUCTED BY MR. F. D. BUMSTED, ENGINEER, HEDNESFORD.



WE illustrate by the annexed engraving an engine and fan designed for producing forced draught for the furnaces of marine boilers. The engine is of Chandler's silent pattern, and it, together with the fan, was made by Mr. Bumsted, of Cannock Chase Foundry, Hednesford, Staffordshire, who has supplied nearly a dozen sets of the same pattern. The steam cylinder is 6½ in. in diameter by 5 in. stroke, and drives a 48 in. fan at 700 revolutions per minute. At a recent test a fan of this size maintained a pressure of 5½ in. of water in a brickwork pit, which had an outlet to the air through which passed 8000 cubic feet per minute. With a wider outlet the discharge rose to 10,000 cubic feet, and the pressure fell to 3 in. The engine runs noiselessly, and the fan is free from "hum."

THE EMPLOYMENT OF SALT FOR THE REMOVAL OF SNOW.

THE current volume of the Minutes of Proceedings of the Institution of Civil Engineers contains an abstract of a memoir on this subject, by Mr. Barabant, which appeared in a recent number of the *Annales des Ponts et Chaussées*. It appears that in 1880 Mr. d'Ussel gave a description of his first attempts to thaw the thin layer of ice in the public streets, produced by the compression of snow by vehicles in time of frost. Since that period, owing to the expenditure of nearly 200,000*l.* in futile attempts to remove the snow in Paris in 1879-80, and 1880-81, the heavy tax has been removed from pounded salt, not suitable for ordinary purposes, enabling salt to be largely used for clearing away snow, a provision of 4000 tons of salt having been made for this purpose in Paris for the winter of 1885-6. A regular service for the removal of snow, on its first appearance, has been organised in Paris, as it is important to clear away the snow before it has been compressed into ice by the passage of vehicles, when it is far more difficult to remove. As falls of snow rarely occur at Paris with a temperature much below the freezing point, salt may be sprinkled on the snow, producing a liquid, of which the temperature may descend to 5 deg. Fahr. without its freezing. The salt should be scattered on the streets as soon as the snow begins to fall fast; the mixture is effected more thoroughly by the traffic, it does not adhere to the ground, and gradually liquefies, so that at the end of four or five hours the streets may be cleared by the sweeping machine, the caoutchouc rake passed over the footpaths, and the mixture washed to the sewers by the addition of water. This cold mixture does no harm to paved roads, asphalt, and wood pavements; but salt should not be used on macadamised roads, which are disintegrated by the frequent artificial thaws thereby occasioned. This affords another reason for discontinuing in large towns the use of macadamised roads, which possess the great disadvantages of being very muddy in rainy weather, or during thaws, and of discharging quantities of sand into the sewers. The employment of salt would probably be very restricted in countries where the temperature often falls below 5 deg.; but everywhere else it furnishes the best means of dealing with snow. It has been suggested that the coldness of the mixture is disagreeable to foot-passengers, destructive to boots, and bad to horses' feet; but the latter can be protected by greasing the inside of the hoof, and as the mixture should be removed directly it becomes liquid, the inconvenience, both to men and animals, is very short in duration, and very slight compared with the advantages and economy of the system. The salt should be scattered in the proportion of about one dram per square foot for each four-tenths of an inch of thickness of snow fallen, or a larger amount if the temperature is low. Formerly each centimetre (0.4 in.) depth of snow falling in Paris necessitated an expenditure of over 2400*l.*, whereas now the cost is only about 800*l.*, or a saving of two-thirds. Moreover, the use of salt dispenses with sanding the streets, which, on the arrival of a thaw, produced quantities of mud in the streets, and deposit in the sewers. Further, if the cessation of interruptions of traffic by means of this process is taken into account, the indirect gain to the people of Paris must be reckoned by millions of francs. Several machines have been devised for the removal of snow, but none of them are as cheap as salt; and the author gives a comparative estimate of the cost of melting snow by steam, and by salt, which shows that the method of steam would be much more expensive, besides entailing other disadvantages. The use of salt will probably not be confined to the clearing of streets in towns, but be extended to all paved roads, to tramways, and to the approaches to railway stations, and all large manufactories. Perhaps, even in France at any rate, salt might be used for dealing with snowdrifts in railway cuttings, by spreading it in sufficient quantities and sweeping thin layers successively salted. On all paved roads over which there is considerable traffic, the use of only half the proportion of salt adopted in Paris would enable a track of 6½ ft. to 10 ft. in width to be dealt with, along which the snow would be prevented from being frozen to the ground, and thus rendering traffic almost impracticable. The small cost of the system, and the advantages to traffic, are sufficient reasons for an early and wide extension of the use of salt for removing snow.

FIRE BOATS.*

By WILLIAM COWLES, New York City.

THE United States Government regulations concerning the matter provide that all steamers shall be equipped with a steam pump or pumps so connected as to be used in case of fire, together with a small supply of 2½ in. hose, pipes, axes, &c.; but this has reference only to self-protection. Heretofore it has been a common custom among corporations having much property on water fronts or afloat, to equip their tugs with a steam pump larger than required by law, and with a little extra hose to be used for the fire protection of their property on shore or on other vessels. Several years ago a number of city governments began to take up and enlarge on this idea, and in 1884 there were a number of fire tugs, regularly owned or chartered as such, being used and managed in connection with city fire departments. But these boats are essentially tugs equipped with comparatively small fire pumps, and, with the exception of the Zophar Mills, of New York City, have very little pumping capacity.

As far as known to the writer, it was in the year 1885 that the first floating fire engine, self-propelling and of high power, was designed and built; this was the Seth Low, of the Brooklyn Fire Department. (See Figs. 1 to 7, page 8 *ante*.) Since the Seth Low two others, somewhat similar but with improvements, have been designed and are now built and in service, one in Cleveland (see Figs. 8 to 13, page 9; Figs. 14 to 19 on the two-page plate of the present issue; and Figs. 29 to 36 on page 36), the other, the Geyser, in Chicago (see Figs. 20 to 28 of two-page plate). Two designs, one wood the other iron, were made for the Cleveland boat, and after receiving bids on both, the wooden boat was decided upon and built.

A comparative table (page 46) has been prepared showing these three boats in contrast with the Zophar Mills, the largest and best of their American predecessors, and the Merryweather, an English contemporary built in 1886, which seems to have been the first of its kind across the water, and of which the chairman of the London Fire Brigade Committee is reported to have said, "It is unquestionably what the committee requires on the Thames."* The Merryweather was built by Messrs. Merryweather and Sons, engineers, London, to the order of the Egyptian Government, for use at Alexandria, and is undoubtedly an excellent fire engine of great capacity considering her size, and may be assumed to be very well suited to a port like Alexandria, but her suitability is not so obvious for use on the water fronts of London or any other very large port. Her reported maximum fire capacity is a single 1⅞ in. to 2 in. stream thrown 200 ft.; about equal to one first-class shore fire engine of the largest size used in American cities. That is, it would take from eight to ten Merryweathers to equal one such boat as Chicago has in the Geyser, and the latter is none too large for efficient use in a large city. The table indicates also a marked difference between the modern boats and the Zophar Mills in dimensions, cost, and capacity. The latter boat is simply an enlargement of the tug idea, an enlargement which makes her very cumbersome and expensive. One of the unparalleled advantages in having fire boats is the capacity thus obtainable for throwing large streams at a large fire. Little streams from ⅞ in. to 1⅞ in., such as the ordinary single shore engine can throw, are almost useless at a large fire except to keep it from spreading; they are vaporised before they can penetrate, thus even adding to the fire, whereas a strong 2½ in. to 3½ in. stream will tear its way through walls, partitions, goods, &c., into the heart of a big fire and break it up so that the small streams can operate on it effectively. There are very few, if any, firemen, even in large cities, who know much about streams above 2 in. in diameter; we must go to these modern, high-power fire boats to find out the power required and the effect with larger streams. So far as known, there are almost no data published in regard to the velocity, nozzle-pressure, volume of water and power required in fire streams above 1⅞ in. in diameter. When these fire boats have been thoroughly experimented with, this knowledge can be obtained for streams up to 4 in. in diameter. It is to be regretted that this has not yet been done. The certain increase in the efficiency of larger fire pumps, with their larger areas and passages, over that obtained in the smaller pumps of shore fire engines, is an important item.

The main features in the design of a high-power fire boat are the boiler and pumps, of course. The boiler must have all the capacity which can be got on a certain prescribed displacement, which means two, three, and even four times the capacity of that in an ordinary tug of similar dimensions. The hull and motive machinery must be secondary matters, as in a dredge or floating elevator. But manœuvring power and speed, in the order mentioned, are also very important items. Then, too, the boats for each port or locality, must have an individuality of their own. A boat designed to suit the conditions and hydrographic features of one port might be entirely unsuitable in another. It would make far too long a paper to go into details in these matters. The plans and table will give much information as to detail to those who feel interested enough to go into the matter. Your attention will be called, however, to a few points.

The ordinary "Scotch" boiler is much lighter per square foot of heating surface than the "water leg" boilers, and for that and several other important reasons it was adopted by the writer as the best type which could be used under the circumstances. By careful designing and by specifying the best material obtainable in the market and the best methods of workmanship, it was proved that the weight of this type of boiler, per square foot of heating surface, could be reduced from 50 lb. and over, as in Transatlantic steamships and United States naval vessels, to 35.26 lb. in the Seth Low, 35 lb. in the Cleveland fire boat, and 31.9 lb. in the boiler of Chicago's Geyser. This calculated weight includes water to 4 in. above highest heating surface, felting and asbestos, breeching, grates, saddles, stack, and attached valves.

These boats are not intended for sea service, and therefore it was permissible to carry the water line higher and use a dry pipe. A ratio of 38 to 1 was also used between the heating and grate surface on account of having a forced draught. These two features explain part of the reduction in weight; the rest of it comes by using the highest grade of material and workmanship, and in cutting out the useless and "dead" water spaces below the furnaces by putting in extra fire tubes and a "regenerating" flue for admitting heated air into the back connection.

Besides the great advantage of throwing large streams and having special and rapid accessibility to all water-front or harbour fires, a properly designed fire boat need not have her field of operations confined to the water front. She may be given such a capacity as to make her a large movable pumping station capable of carrying her equipment, crew, coal, &c., to the nearest practicable point, and operating from that point with unlimited water supply upon a fire 1200 ft. to 1500 ft. distant through several lines of hose of large size. And even beyond this 1500-ft. belt, fire boats can be used to reinforce shore engines, the latter either connecting their suctions direct

* Paper read before the American Society of Mechanical Engineers.

* See ENGINEERING, June 18, 1886.

COMPARATIVE TABLE OF DIMENSIONS OF FIRE BOATS.

Boiler.

Data.	"Geyser," of Chicago.	Cleveland Boat. Built (Wood).	Cleveland Boat. Not Built (Iron).	"Seth Low," of Brooklyn.	"Zophar Mills," of New York.	"Merryweather," of Alexandria, Egypt.
Type, description, and number.	Scotch — four furnaces, horizontal steam drum athwartships — forced draught—one.	Scotch — three furnaces, vertical steam drum and superheater — forced draught—one.	Same as in wood boat.	Scotch — three furnaces, vertical steam drum and superheater — forced draught—one.	Flue and return tubular "water leg." Two furnaces, steam chimney—natural draught—two.	Vertical cylinder "drop tube" fire engine type—forced draught—one.
Dimensions of shell over all	11 ft. 4½ in. in diameter by 16 ft. long.	10 ft. 1 in. in diameter by 14 ft. long.	.. ..	9 ft. 3 in. in diameter by 14 ft. long.	8 ft. face and diameter by 14 ft. long.	About 3 ft. 6 in. in diameter by about 6 ft. high.
Dimensions of furnaces ..	36 in. in diameter by 13 ft. 10 in. long. Grates 7 ft. long.	86 in. in diameter by 11 ft. 10 in. long. Grates 7 ft. long.	.. ..	33 in. in diameter by 11 ft. 10 in. long. Grates 6½ ft. long.	39 in. wide by 6½ ft. long.	About 3 ft. 3 in. in diameter.
Working pressure	100 lb.	100 lb.	.. ..	100 lb.	60 lb.	120 lb.
Grate surface	84 sq. ft.	63 sq. ft.	.. ..	53.6 sq. ft.	About 86.5 sq. ft.	About 8.3 sq. ft.
Heating surface	3091 ,,	2269 ,,	.. ..	1810.5 sq. ft.	,, 2040 ,,	275 sq. ft.
Ratio of G.S. to H.S. ..	1 to 38	1 to 36	.. ..	1 to 34.1	1 to 23.6	About 1 to 33.
Weight complete, steam up	44 tons	35 tons	.. ..	28.65 tons	Over 50 tons	About 2 to 2½ tons.
Weight per sq. ft. H.S. ..	31.9 lb.	34.55 lb.	.. ..	35.26 lb.	About 55 lb. to 60 lb.	About 16 lb. to 19 lb.
Material	Otis steel plates, 65,000 to 70,000 T.S.; 47 to 50 per cent. "contraction of area," 25 per cent. elongation. Stays and rivets of iron, 52,000 T.S., 32 per cent. elongation.	Otis steel plates, same as Geyser.	.. ..	Shoenberger and Co.'s steel plates, 60,000 to 65,000 T.S., otherwise same as Geyser.	Iron plates, 50,000 T.S.	
Builders	John Mohr and Son, engineers, Chicago.	Cleveland Steam Boiler Works, Cleveland.	.. ..	McWilliams and Brown, engineers, Jersey City.	Pusey and Jones, engineers, Wilmington, Del.	Merryweather and Sons, Engineers, London.

Pumps.

Type and builders	Vertical duplex cranks and flywheels, steam valves ordinary slide, water valves special form, rubber, with extra large area and straight ports. Clapp and Jones Mfg. Co., Hudson, N.Y.	Same type as in Geyser, but different design—valves as in Amoskeag fire engines. Thos. Manning and Co., engineers, Cleveland.	Same specification as for wood boat.	Same type and design as in Geyser, with different water valves. Clapp and Jones Mfg. Co., Hudson, N.Y.	Same type and similar design to pumps in Seth Low, same valves. Clapp and Jones Mfg. Co., Hudson, N.Y.	Horizontal direct-acting "double cylinder," known as "Admiralty" pattern. Merryweather and Sons.
Number of pumps	Two.	Two.	..	Two.	Two.	One
Total number of water cylinders and their dimensions.	Four—9 in. in diameter by 10 in. stroke.	Four—8 in. in diameter by 10 in. stroke.	..	Four—8 in. in diameter by 10 in. stroke.	Four—7½ in. in diameter by 9 in. stroke.	Two—7 in. in diameter by 24 in. stroke.
Total number of steam cylinders and their dimensions.	Four—17 in. in diameter by 10 in. stroke.	Four—16 in. in diameter by 10 in. stroke.	..	Four—16 in. in diameter by 10 in. stroke.	Four—16 in. in diameter by 9 in. stroke.	Two—9 in. in diameter by 24 in. stroke.

Hull.

Material	Wood	Wood	Iron	Wood	Iron	Iron.
Net register tonnage ..	71.60	33.08	..	41.36	121.05	
Displacement to L.W.L. ..	201 tons*	136 tons*	125 tons*	157.5 tons†	About 380 tons	
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Length over all	105 0	79 0‡	78 0‡	99 3	,, 122 0	51 0
Length on L.W.L.	95 5	70 0	71 6	90 0		
Beam over all	24 8¾	23 4¾	22 11½	23 9		
Beam over plank or plating	23 0	22 8	22 2½	23 0	25 0	10 6
Beam on L.W.L.	21 8	22 0	21 7	22 3		
Depth, moulded	11 0	10 0	10 0	8 6	9 0	
Draught, extreme	8 10	8 4	7 7	7 6	9 9	4 0
Coal capacity in bunkers (tons of 2000 lb. each)	27 tons	12 tons	15 tons	18 tons	20 tons	Very small.
Number of men that can be quartered on board	16	10	14	14	About 16 to 20	Very few.
Builders	Miller Bros., Chicago.	Murphy and Root, Cleveland.	.. ..	Trundy and Murphy, Brooklyn,	Pusey and Jones, Engineers, Wilmington.	

Motive Power.

Type of engine and number of cylinders.	Simple, vertical, direct-acting. Two cylinders on wrought-iron columns.	Simple, vertical, direct-acting. One cylinder on cast-iron frame.	Same specification as for wood boat.	Two separate engines for twin screws—simple, vertical, direct-acting. One cylinder each—on cast-iron frames.	Simple, vertical, direct-acting. One cylinder on cast-iron frame.	Simple, vertical, direct-acting. Two cylinders on cast-iron frames.
Diameter of cylinders ..	18 in.	18 in.	.. ..	16 in.	30 in.	9 in.
Stroke of pistons	20 ,,	20 ,,	.. ..	18 ,,	30 ,,	10 ,,
Remarks	Links, no cut-off valves, steam reverse gear, exhaust to atmosphere or through heater, and stack for blast.	Same as Geyser—hand reverse gear.	.. ..	Links, Mayor cut-off valves, exhaust to "high-pressure" surface condenser, or to stack for blast.	Link, steam reverse gear, extremely heavy parts all through—exhaust to surface condenser, no steam blast in stack.	Ordinary double engine, exhaust to stack—no condenser.
Builders	C. F. Elmes, engineer, Chicago.	Excelsior Iron Works, Cleveland.	.. ..	McWilliams and Brown, Jersey City.	Pusey and Jones, engineers, Wilmington.	Merryweather and Sons.
Propeller wheels — number and type.	One—Four blades, removable, of cast-steel. Blade surface half-way between towing and speed wheel.	One—Kunstadter patent, swivel joint for manœuvring in Cuyahoga River—very crooked and narrow. Four blades, removable, cast steel—blades 22 in. wide at centre of length.		Two—Four blades, solid, cast-iron — blade surface half-way between towing and speed wheel.	One—Four blades, cast-iron, heavy towing wheel.	One—Three blades, ordinary form.
Diameter of wheel	7 ft. 10 in.	6 ft.	.. ..	6 ft.	8 ft. 6 in.	About 8 ft. 6 in.
Pitch of wheel—average ..	12 ft.	9 ,,	.. ..	9 ,,	13 ft.	
Approximate total cost of boat complete, excepting fire equipment.	36,870 dols.	25,200 dols.	.. ..	33,000 dols.	About 60,000 dols.	

From Tests of Pumps.§

Largest stream and distance.	One 3½ in.—431 ft., or one 4 in.—386 ft.	One 3½ in. — 275 ft. not a maximum.	.. ..	One 3½ in.—360 ft.	Maximum with both pumps. One 3 in.—300 ft.	One 2 in.—200 ft.
Capacity in 2 in. streams and distance.	With one pump, four 2 in.—249 ft. with both pumps, one 3 in.—234 ft., and four 2 in.—220 ft. at one time.	With one pump three 2 in.—240 ft.	.. ..	Four 2 in.—250 ft.	Two 2 in.—240 ft.	,, 2 ,, —200 ,,
Capacity in small streams	Fourteen 1¼ in.—204 ft.	Four 1¼ in.—170 ft. and six 1 in.—215 ft.	.. ..	Twelve 1 in.—185 ft.		

* In fresh water. † In salt water. ‡ The designer was limited to an over all length of 80 ft.
§ All distances measured horizontally to end of solid water, all spray excluded.

to the delivery from the fire boat, or the boat can deliver into tanks from which the engines can draw. Scarcity of water for large fires is a thing of which many large cities have to complain. Again, special pipes or mains can be laid connecting the nearest convenient point on the water front with any desired building or district in a city, the fire boat connecting with the main and operating somewhat on the Holly system.

These fire boats are designed to keep up steam constantly. A banked fire in one of the furnaces, with the others primed ready to start, is found to work well. The boats are put on the regular fire alarm and telephone circuits by special slip cable connecting with the instruments permanently located in the pilot house, and the boats can make much better time in going to a fire than the shore engines can, because they are able to start as quickly, have generally less obstruction, and always very much more speed. When we consider the cost of real estate and building in a city of the first or second class, it is plain that a first-class fire boat, fully equipped, and with a capacity for throwing six to eight strong 2-in. streams, can be had at about the same cost as a shore engine throwing one 2-in. stream, when to the cost of the latter is added the outlay for hose and carriage, equipment, house and lot, horses, and other matters necessary to maintain the engine and crew. It is safe to say that an improved form of floating fire engine is the cheapest and by far the most efficient method for the fire protection of shipping and water front districts in large or small ports, and that such machines are destined to come into more general favour. From the studies and experience of the writer in the matter, he has concluded that it is quite possible to build and equip complete, ready for service, a small floating fire engine with a capacity of two to three first-class shore engines (two to three 2-in. streams), suitable for a small port, for 20,000 dols., and one of half this capacity for 14,000 dols. This includes the cost of hose, pipes, nozzles, &c., which is always quite a large item.

PHILADELPHIA.—Philadelphia is now estimated to have a population of nearly 1,000,000.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

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MACHINE TOOLS.

13,100. E. Hughes, Kirkdale, Lancaster. Feed Motion or Apparatus for Feeding Timber to Circular and other Saws. [8*d.* 2 *Figs.*] October 30, 1885.—The improved feeding apparatus consists of a continuous chain operated by a revolving shaft or drum, and passing along the side of the machine, with a dog or coupling bar, one end of which fastens into the end of the plank or log, while the other end hooks into or engages with the links of the chain. (*Sealed December* 31, 1886).

14,429. T. Hill, Derby. Cold Steel and Iron Sawing Machines. [8*d.* 3 *Figs.*] November 25, 1885.—According to this invention the circular saw is fixed by countersunk rivets to a disc fastened to the spindle so as to give to the saw a surface free from projections on the work side, thus enabling the saw to cut off runners, &c., on castings quite flush with the casting. (*Sealed December* 10, 1886).

15,191. R. Arnold, Strasburg, Germany. Diamond Pointed Cutting Tools and Machinery for Use with the Same. [1*s.* 3*d.* 13 *Figs.*] December 10, 1885.—This invention relates chiefly to an improved method of setting diamonds and other hard-cutting bodies in steel bearers, and of arranging these bearers provided with diamonds in saw blades and other tools. (*Accepted December* 10, 1886).

15,431. T. Bramwell, Stockport, Chester. Boring Tools to be Used in Lathes and other Machines. [8*d.* 8 *Figs.*] December 16, 1885.—The object of this invention is to make a boring bar to carry varying sizes of cutters, which can be readily moved or expanded to compensate for wear or for other purposes. Loose cutters with inner bevelled faces are combined in the boring bar with a cone-pointed screw for adjusting the cutting faces. (*Sealed December* 21, 1886).

2869. W. Muir, London. Apparatus for Communicating Reciprocating Motion to Planing and other Machines. [8*d.* 6 *Figs.*] February 27, 1886.—This apparatus comprises four coned sectional nuts, each nut consisting of four pieces A, B, C, D, of conical shape and provided with a screw thread on their inner faces. The nuts are connected in pairs and are capable of being simultaneously opened and closed to release and grip the right and left-hand threaded shafts K, L, on which each pair travel. This opening and closing operation is effected

Fig. 1.

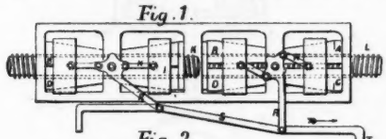
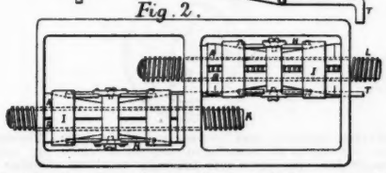


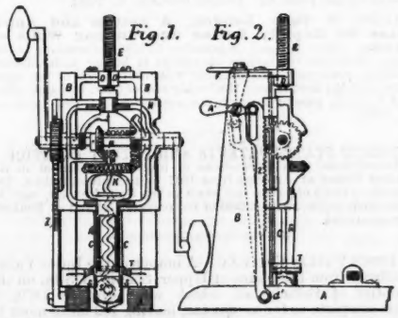
Fig. 2.



by bands or rings I, the inner portions of which are grooved for engaging and sliding upon shaped projections on the sections of the nuts. The two rings I of each pair are connected by links N and a lever R, and the two pairs are connected by a rod S. The two pairs of nuts working on the threaded shafts K, L, can be automatically thrown into and out of action by the extensions T, T of the rod S striking against a stop set on the side of the machine. One of the shafts may have a thread of a much quicker pitch so as to produce a quick return movement of the planing table. (*Sealed October* 15, 1886).

8818. M. Rothschild, Shamokin, Penn., U.S.A. Mortising Machines. [6*d.* 5 *Figs.*] July 6, 1886.—This invention relates to improvements in tools for boring square holes. Two standards B, B rising from the base A, are connected at the

Fig. 1. *Fig. 2.*



top by a plate on which are pivotted two semi-cylindrical jaws D, D, provided with internal screw threads intended to engage with the feed screw E. A knuckle lever F serves to close up the jaws against the feed screw. Springs acting on the tails of the jaws, have a tendency to throw the jaws open. A tubular guide R extending from the bottom part of the frame H is provided with ribs *c*, *c*, which engage with grooves in a traverse T secured to the standards B. On the guide R are mounted four circular saws S, S, which are secured to the outer surfaces of bevel wheels, and which together with the bevel wheels turn freely on screw studs. The drill rod extends beyond the lower edge of the guide R, and carries the bit X and a master wheel gearing into the bevel wheels of the saws. On imparting a revolving motion to the drill rod by means of the driving shaft and the bevel wheels, the saws S are caused to revolve. A rack bar Z which springs on a pivot *d*, can be thrown in or out of gear with the cogwheel Y on the driving shaft by means of a lever A^1. When the machine is in operation the jaws D, D are closed, and the rack bar Z is thrown out of gear as shown in dotted lines (Fig. 2), but when a hole has been bored, the rack bar is thrown into gear with the cogwheel Y, the jaws D are opened, and by turning the driving shaft, the frame H, together with all its appliances, can be raised ready for the next hole. The clearer K consists of a spiral wire extending through the hollow drill rod. When the tool is in operation, the clearer is rotated by means of the bevel wheels P, so that the chips are discharged at the upper end of the drill rod. Holes of various shapes can be bored by changing the number of saws S. (*Sealed October* 12, 1886).

10,808. J. B. Sibbald, London. (*G. W. Miltmare, Arlington, Vermont, U.S.A.*) **Dressing and Hardening the Surfaces of Car Wheels.** [1*s.* 1*d.* 18 *Figs.*] August 24, 1886.—This invention is based on the well-known principle that fusion of a metallic surface will take place on its presentation to a rapidly revolving disc. According to this invention a car wheel has its tread dressed and hardened by burning and melting away the original surface of the tread by means of a rapidly revolving disc, the periphery of which may be either smooth or the counterpart of the tread to be dressed. The hardening effect can be increased by applying water to the dressed surface of the wheel as it leaves the disc. This invention may be applied for dressing chilled rolls, and also flat metal bodies. (*Sealed December* 10, 1886).

SMALL TOOLS.

33. F. Perner, Elbeteinitz, Austria. Tube Brushes or Cleaners. [8*d.* 4 *Figs.*] January 1, 1886.—The improved brush for cleaning tubes or tubular objects comprises a number of star-shaped plates having flexible points or fingers, the star-shaped plates being secured upon a rod so that the fingers of each plate coincide more or less with, or are opposite to, the fingers of the adjacent plates. (*Accepted November* 2, 1886).

2600. J. Brown, London. Spanners. [8*d.* 8 *Figs.*] February 23, 1886.—The spanner is formed in two parts, one part carrying the upper jaw and the other part the lower jaw. The two parts are connected together by a stud formed on one lever, which enters a hole in the other lever. The two parts or levers are further connected by a loose collar or ring surrounding both levers. (*Sealed October* 26, 1886).

4898. J. Hatton, Stourbridge, Worcester. Improvements in the Manufacture of Spades, &c. [8*d.* 13 *Figs.*] April 8, 1886.—The improvements consist in fixing a centre strap of wrought iron or steel to the socket part of a spade, shovel, draining tool, rake, or agricultural fork by means of a projection on the strap which passes through a hole in the socket part, and is there rivetted over. (*Sealed December* 27, 1886).

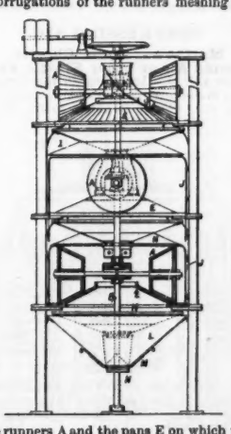
8556. A. Paice, Ryde, Isle of Wight. Bit for Boring Holes. [8*d.* 3 *Figs.*] June 30, 1886.—This invention relates to a bit for boring round holes, the bottoms of which are quite level and without either the usual indentations made by a point or screw in the centre, or cutter marks round the circumference. The bit consists of a steel tube with a cutter or cutters extending from the outside to the centre. The cutting edge projects from the end of the tube the thickness of the shaving to be taken. The shavings pass up the tube to an outlet provided for their exit. (*Sealed December* 10, 1886).

10,589. W. F. Stanley, London. Portable Saws. [6*d.* 8 *Figs.*] August 18, 1886.—Inventor claims the method of rendering a saw portable for mechanical work by making the teeth in separate pieces, which are jointed together by rivets in such a manner as to make the saw capable of being folded up into a small space. (*Sealed November* 26, 1886).

11,337. E. G. Odelstjerna, Linde, Sweden. Manufacture of Axes, Hammers, Chisels, and similar Articles. [6*d.* 3 *Figs.*] September 7, 1886.—According to this invention, axes, hammers, &c., are cast from chromic Martin metal into chills, direct from a Martin furnace. (*Sealed December* 31, 1886).

GRINDING AND CRUSHING MACHINERY.

14,358. W. S. Akerman, Bridgwater, Somerset. Mills for Crushing, Pulverising, and Sifting Minerals, &c. [8*d.* 4 *Figs.*] November 23, 1885.—The several sets of edge runners or rollers A are driven by the same vertical shaft B, and are alike in construction except that the top set may be corrugated (the corrugations of the runners meshing with those of



the pan). The runners A and the pans E on which they run, are of a conical or bevelled form. A central hopper fixed to the shaft B above each pan E is provided with a pair of spouts *g* for continuously delivering the matters to be ground on to the pan in front of the runners, the hopper and spouts being carried round with the shaft. Beneath each pan E is hung an inverted conical sieve H into which the matters are discharged from the circumference of the pan above. Under each sieve H (except the lowermost one) is a conical shoot I coned the reverse way to the screen, for discharging circumferentially the fine flour or dust which has passed through the meshes of the screen. The lower portion of the cone is not perforated, and forms a shoot in continuation of the screen, and has a central aperture by which the coarse meal is delivered to the hopper supplying the set of runners next below. The screen and shoot H are suspended loosely by chains or links, and receive a vibratory motion from a tappet on the vertical shaft striking lugs on the inside of the central delivery aperture of the screen. Each conical shoot I discharges into a circumferential spout J leading between the double walls of the external casing. The siftings of the several screens are collected in a hopper L provided with discharging doors M, and which is also provided with a central spout N for receiving the coarse residue from the last screen H. (*Sealed November* 30, 1886).

15,504. W. McLean, Goulburn, New South Wales. An Improved Mechanical Motion Specially Applicable to Quartz Crushing and like Machines. [8*d.* 7 *Figs.*] December 17, 1885.—The stampers C are arranged closely together in a stamper box D, Fig. 1, so that their centres are equally distant from the centre of the main wheel A. The stampers are lifted by cams or inclined planes B which are hinged

Fig. 1.

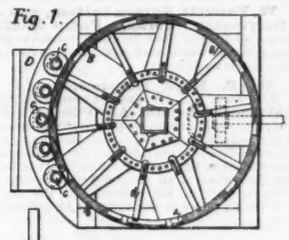
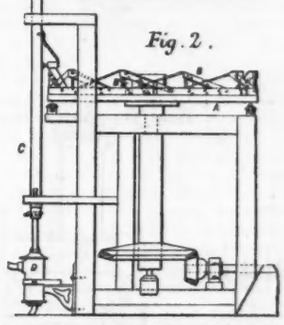
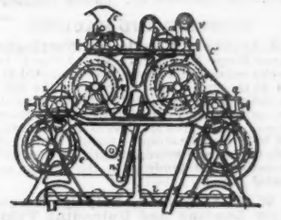


Fig. 2.



at their lowest point to the periphery of the wheel A. The upper ends of the inclined planes are supported by adjustable supports B^2. By these means the amount of lift may be altered as required. The adjustable inclined planes B may be used in combination with any machinery in which reciprocating motion is required, such as pumping cylinders D, Fig. 2. (*Sealed January* 4, 1887).

8532. R. Morrell, Summit, New Jersey, U.S.A. Improvements in Roller Grinding Mills. [8*d.* 2 *Figs.*] June 29, 1886.—This invention relates essentially to a plan of construction by which mills having four or five pairs of rollers and the usual complement of screens, can be comprised in a single machine of which the height will be within the limits of the usual height between the floors of ordinary mill buildings, without material increase of the longitudinal dimensions. The first pair of break rolls *b* are arranged in the top corner of one end under the feed hopper *c*; under these is the first concave screen *e* with its



fans and brushes for separating the fine flour by brushing it through the screen, and discharging the coarse "chop" down the shoot *h* to the next pair of break rolls *i*. The screen e^1 of the second separator is located in the lower part of the machine just above the conveyor *l*, and discharges into the elevator *n* for carrying the "chop" to the second set of rolls and separators *m*, e^2, and *q*, e^3. The fine flour discharges into the conveyor *l* from all the screens except the first one, which discharges into a separate conveyor, and the bran escapes through the spout *y*. The driving pulley is located under the floor and drives all the rolls with a single idler *v* by means of a belt e^4. (*Sealed October* 12, 1886).

PUMPS.

13,614. J. Y. Johnson, London. (*V. G. Bell, Kingston, Jamaica.*) **Rotary Motive Power Engine or Pump.** [8*d.* 7 *Figs.*] November 9, 1885.—The shaft 1 revolves in a bearing 3 formed in the cylinder cover 4. The pin of the crank 2 which forms part of the shaft 1, works in a bearing in the axis of the piston 5. Fig. 3 is a view of that side of the piston nearest the shaft 1. A toothed wheel 6 concentric with the shaft 1, and rigidly attached to the cylinder cover, and whose diameter at the pitch line is equal to twice the throw of the crank 2, gears with an internal toothed wheel 7 having double the number of teeth, formed in the piston 5 concentrically with the crank-pin 2. These wheels determine the motion of the piston relatively to that of the crank and shaft, causing the piston to describe a trochoidal curve, and to make half a revolution round the crank-pin during each complete revolution of the shaft. Constant contact between the curved surface of the cylinder and the extremities of the piston is effected by providing the latter with rocking shoes 12.

When the piston is at right angles to the arm of the crank, the engine is at its dead point; this is the end of one stroke and the beginning of the next. The larger space of the cylinder S being now open to the external air, and steam or other fluid pressure being admitted into the smaller space below the piston (Fig. 1), and the piston being carried past the dead point by its own

Fig. 1.

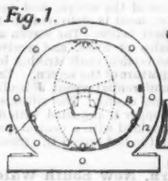


Fig. 2.

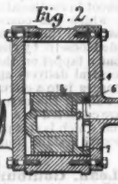
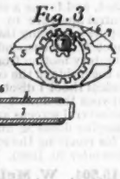


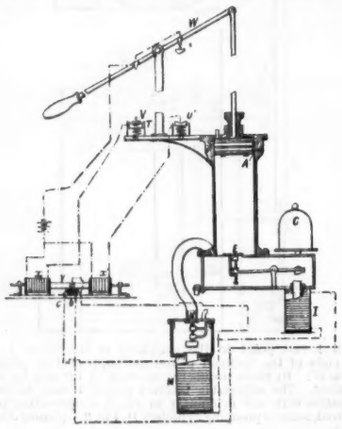
Fig. 3.



momentum, the excess pressure on the one face of the piston will tend to cause the revolution of the crank and the shaft. The admission and exhaust passages are preferably arranged in the interior surface of the cylinder, so that the piston acts as its own valve. This engine may be used as a pump if driven by a power externally applied to the shaft. (*Accepted September* 7, 1886).

14,734. W. Fawcett, Burton Salmon, and A. Thomlinson, Darrington, Yorks. Pump Buckets. [8*d*. 3 *Figs*.] December 1, 1885.—This invention relates to the construction of a pump bucket which discharges through its hollow pump rod. (*Sealed December* 7, 1886).

15,561. W. E. Heys, Manchester. (*A. B. Worth, Greenport, New York, U.S.A.*) **Improvements Applicable to the Valves of Vacuum Air Pumps.** [8*d*. 3 *Figs*.] December 17, 1885.—In vacuum air pumps the pressure in the receiver which is being exhausted of air becomes less and less until finally it is not sufficient to operate the valve, although practically there is some air left in the receiver. The object of this invention is to provide the valves of an air pump with devices adapted to operate independently of the pressure in the receiver. The operation of the air pump is the same as in ordinary air pumps



except as regards the valves. The piston A of the air pump is operated by a handle W. The receiver C communicates with the pump cylinder through the valve E. When the contact points V and T come together a current passes through the electro-magnet X and draws the core Y to the left, so that the current can pass through the contacts *b*, *c*, into the electro-magnet M which operates the valve K, and keeps it open until the contacts V^1 and U^1 switch the current through the electro-magnet X^1, drawing the core Y to the right, and thereby allowing the current to energise the electro-magnet I, which keeps the valve E open until the contacts V and T come together again. (*Sealed November* 23, 1886).

HOISTING AND HAULING.

15,969. J. Archbold, Newthorpe, Nottingham. Clips for Endless Rope Haulage. [8*d*. 4 *Figs*.] December 29, 1885.—The clip consists of a pair of jaws connected at their upper extremities to the eye of the hook or to the link of a chain attached to the weight to be hauled, whilst their lower extremities are grooved on their inner opposite faces to grip the rope passing between them. These jaws are tapered on the outside, and are surrounded by a metallic strap or ferrule, which, when pushed down on the thicker part nearest the groove, effectually locks the two jaws together, and firmly grips the haulage rope between them. (*Sealed January* 4, 1887).

16,097. W. R. Stegmann, Leipzig, Germany. Apparatus for Loading and Unloading Vehicles and Generally Applicable for Raising and Lowering Goods on Inclines. [1*s*. 1*d*. 22 *Figs*.] December 31, 1885.—This apparatus or ladder comprises principally two parallel main beams between which is a screw spindle held at its ends by a pair of crossbeams; and a carriage connected with the screw spindle by nuts and four or two pulleys mounted on two horizontal axles (one at each end of the ladder) to be used instead of the screw spindle or in combination with the same. Over each pair of pulleys passes an endless rope or chain, the ends of which are fixed to the carriage. (*Sealed January* 4, 1887).

ROCK DRILLS.

8839. N. C. Pond, M. O. West, and E. Simons, Port Chester, New York, U.S.A. Rock-Drilling Machine. [8*d*. 5 *Figs*.] July 6, 1886.—This invention relates to that class of rock-drilling machines which operate by successive thrusts of the drill. All the working parts are supported by a carriage J fitted to slide vertically upon the side ways D of the frame of the machine. The rock drill L is fixed to a spindle K, which is journalled by means of a grooved collar Q to rotate in the longitudinally reciprocating crosshead M which slides freely on the side bars of the carriage J, and is connected by leather straps N with cranks O, O, of a shaft P. The first half-revolution of the cranks O, drawing by the straps N upon the crosshead M, pulls the drill spindle up to its uttermost limit against the resistance of the spiral spring R. The instant the cranks pass over their dead centre, they no longer resist the action of the spring, and are revolved forward by the straps N ahead of the speed of the handwheel S, while the drill is thrown violently into the rock by the action of the strong spring R. By means of a pawl and ratchet connection between the wheel S and the crankshaft P, two full throws of the drill are given by each revolution of the handwheel. The drill is rotated a little so as to take a new chip at each throw, by means of a ratchet wheel *c*. A feed lever *k* is forced by a spring *m* to rest its lower end against the spindle. At each throw of the spindle, the lever *k* is tilted to return the hook *l* to engage more teeth of the ratchet nut *g*, and when the spindle is next raised the collar Q gradually releases

Fig. 2.

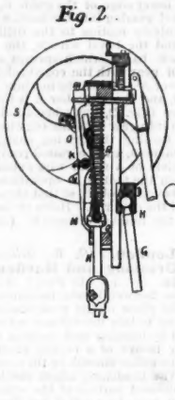
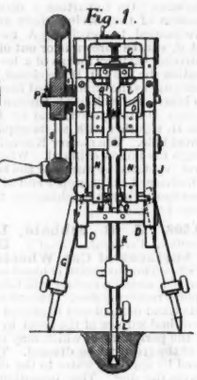


Fig. 1.



the inclined end of the feed lever, permitting the spring *m* to steadily return the lever and pull the ratchet nut around the feed screw, thereby feeding the carriage and the drill downward automatically slow or fast in proportion as the work being done by the drill is hard or easy. The two side legs G are connected to the frame of the machine by ball-and-socket joints H. (*Sealed October* 26, 1886).

DRAWING, ROLLING, AND FORGING.

11,494. J. G. Parker, London. Manufacture of Metal Wires, Tubes, and Rods, and Apparatus therefor. [8*d*. 6 *Figs*.] September 26, 1885.—According to this invention metal wire, bars, rods, or tubes being of a grooved, corrugated, toothed, or stellar form in cross-section, are formed with longitudinal wings, ribs, webs, bars, ridges, grooves, or indentations by being passed between revolving discs or rolls. (*Sealed December* 3, 1886).

13,628. J. A. Crane, Birmingham. Reduction of Iron and Steel Tubes. [4*d*.] November 10, 1885.—Inventor claims the reduction in thickness and diameter of a "butt welded" tube by means of a mandrel combined with the usual drawing apparatus. (*Sealed December* 17, 1886).

15,170. J. D. Grey, Bridgend, Glamorgan. Improvements in the Method of Rolling Steel and Iron Bars or Plates for the Manufacture of Tin or Tern Plates. [6*d*.] December 10, 1885.—The improvements consist in forming the steel ingot or iron bloom of about the required width of the plates, then rolling the bloom into bars or plates at one heating in a pair of recessed or grooved rolls, and imparting a clean smooth surface to the bars or plates by passing them while still hot through a pair of smooth rolls. (*Sealed December* 17, 1886).

15,245. T. Brown, Wallsall, Staffs., and J. G. Gordon, Landore, Glamorgan. Improvements in Machinery for Rolling Steel and Iron. [6*d*.] December 11, 1885.—The chief improvement consists in combining a pair of horizontal rolls with a pair of vertical rolls, both rolls having a reversing motion, so that the bloom can be passed backwards and forwards through the same groove without the necessity of removing the bloom from one groove to another or having to turn the bloom on its edge for reducing its width. (*Sealed December* 14, 1886).

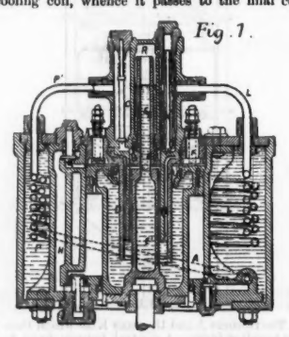
4741. A. J. Boult, London. (*E. B. Stocking, Washington, New York, U.S.A.*) **Method of Reducing Old Steel Rails or Scraps to Plates and the like.** [8*d*. 11 *Figs*.] April 5, 1886.—This improved method consists in reducing the head and flange of the old rail by lengthwise and sidewise or transverse rolling, beginning at or about the middle without severing the rail. (*Sealed December* 24, 1886).

11,989. H. Sack, Duisburg, Germany. An Improved System of Rolls for Rolling ⊦ and Similar Iron. [6*d*. 4 *Figs*.] August 31, 1886.—The improved system of rolls for rolling certain forms of building iron consists of two parallel rolls driven by power, combined with a pair of parallel rolls whose axes lie in the same plane as those of the first pair, and each of which is shaped so as to enter between corresponding surfaces on the ends of the first pair of rolls. (*Sealed December* 31, 1886).

COMPRESSING AIR.

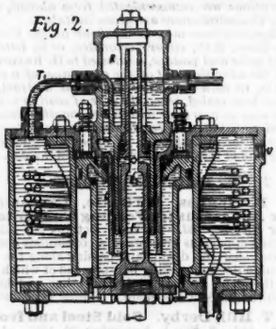
14,904. R. Matthews, Hyde, Chester. Apparatus for Compressing Air or other Elastic Fluids. [8*d*. 4 *Figs*.] December 4, 1885.—According to this invention, the air, after receiving a preliminary compression, is forced into an intermediate cooling coil, whence it passes to the final compressing

Fig. 1.



stage, and is delivered hence to a final cooling coil. The main cylinder A contains a trunk piston B, which slides with a packing upon the cylindrical jacket C surrounding the inner cylinder D, both the jacket and the inner cylinder being formed on the cover. The cylinder D contains a piston E with a tubular piston-rod E^1 connected to the piston B. The piston-rod E^1 has a tubular extension E^3 extending up into the chamber R. The air is admitted above the piston B through an annular valve F during the downstroke of the piston. At the upstroke of the piston this charge of air is compressed and forced through the valve G, passage H, and valve I into the annular space surrounding the trunk of the piston B. On the following downstroke of the piston B this charge is still further compressed and forced through the valve K into the intermediate cooling coil L, whence it is delivered through the pipe L^1 into the chamber of the valve N, through which it passes into the inner cylinder D as the piston E is performing its down-

Fig. 2.



stroke. On the upstroke of the piston E the air receives its final compression and is forced through the valve O and the pipe P^1 into the second cooling coil P, and is led away through the pipe Q. The cooling water enters by the pipe T into the chamber R, descends on the downstroke of the piston E through the tubular extension E^3, passes through the holes E^2 into the annular space between E^1 and D, in which it descends into the trunk piston B, whence it is forced on the upstroke of the piston through the annular passage between D and C, through the passage T^2 and the pipe T^1 into the cooling jacket M. The cooling water is finally led away through the exit orifice U. (*Sealed December* 10, 1886).

CENTRIFUGAL MACHINERY.

10,552. W. R. Lake, London. (*J. Evans, Philadelphia, and D. H. Burrell, Little Falls, New York, U.S.A.*) **Centrifugal Apparatus for Separating Liquids of Different Densities or Specific Gravities.** [8*d*. 7 *Figs*.] August 17, 1886.—This apparatus is adapted for separating wool scourings into their three component liquids—the wool grease or oil, the washing solution, and the semi-liquid impurities. The scourings are fed into the rapidly rotating drum through the feed pipe I and are caused by centrifugal force to arrange themselves in three distinct

Fig. 1.

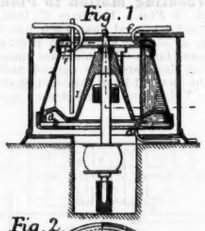


Fig. 2.

concentric layers against the outer wall of the drum. The outer layer consists of the semi-liquid impurities which are forced through the openings *d* into the lower receiving chamber D, whence they are removed by the skimming pipe d^1. The next inner layer is composed of the lighter washing solution, which escapes through the openings *f* into the upper collecting chamber F, and thence through the pipe f^1. The innermost layer consists of the wool oil or grease and is removed from the drum by the skimming pipe *g*. (*Sealed December* 17, 1886).

MISCELLANEOUS.

15,495. J. R. Parkes, Birmingham. Improvements in Beaters for Cleaning Grain and for other like Purposes. [8*d*. 3 *Figs*.] December 17, 1885.—The improvements consist in forming on one or both faces and on the edge or edges of the beaters sharp teeth, projections, or grooves, by the action of which the impurities attached to the grain are effectually broken up and removed. (*Sealed December* 31, 1886).

11,397. O. Terp, London. A System and Apparatus for Rapidly Boring and Sinking Wells or Shafts. [11*d*. 8 *Figs*.] September 7, 1886.—According to this improved system the various operations of boring with different drills are performed consecutively without removal of the apparatus over the bore-holes; the boring rod or tube, in being raised and lowered, passing through the apparatus. (*Sealed December* 24, 1886).

UNITED STATES PATENTS AND PATENT PRACTICE.

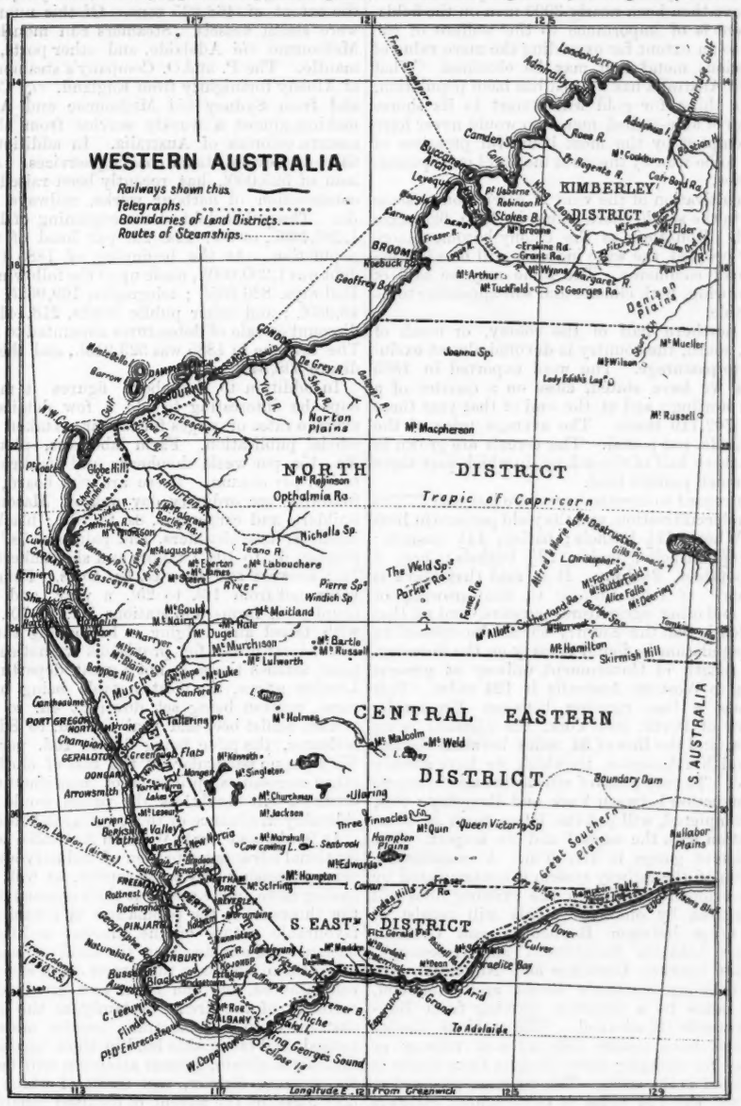
Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

INDUS VALLEY RAILWAY.—A branch of the Indus Valley Railway from the plains of Upper Scinde to Sibi, on the frontier of Beluchistan, which was begun in 1879, is now complete as far as Quetta, leaving 100 miles more to be constructed. The work has been hindered partly by the vacillating policy of the Government, and partly also by difficulties met with on abrupt mountain chains.

WESTERN AUSTRALIA.

WESTERN Australia is the largest in area and least in population of our Australian colonies. It extends over more than a million square miles of territory, stretching from north to south for a distance of 1280 miles, and from east to west about 800 miles. It is therefore about equal to all Germany, France, Spain, Portugal, Austria, Denmark, Holland, Greece, and Belgium put together. This enormous extent of country, eleven times as big as Great Britain, is peopled by only 35,186 souls, which is rather less than the one-thousandth part of the population of the United Kingdom.

Western Australia is still a Crown colony, the Government officials being appointed by the English


WESTERN AUSTRALIA
Railways shown thus
Telegraphs.
Boundaries of Land Districts.
Routes of Steamships.
KIMBERLEY DISTRICT
NORTH DISTRICT
CENTRAL EASTERN DISTRICT
S. EAST^N DISTRICT
Tropic of Capricorn
S. AUSTRALIA
Londonderry
Admiralty G.
Camden H.
Prince Regents R.
Rose R.
Collier Bay
Roebuck Bay
Broome
Geoffrey Bay
Joanna Sp.
Mt Mueller
Mt Wilson
Mt Russell
Mt Macpherson
Nicholls Sp.
Teano R.
Mt Augustus
Mt Labouchere
Pierre Sp.
Windich Sp.
Mt Maitland
Mt Murchison
Mt Bartle
Mt Russell
Mt Lulworth
Mt Luke
Mt Holmes
Mt Malcolm
Mt Weld
Mt Kenneth
Mt Singleton
Mt Churchman
Ularing
Mt Jackson
Three Pinnacles
Mt Quin
Queen Victoria Sp
Hampton Plains
Mt Edwards
Mt Hampton
Mt Stirling
Boundary Dam
Mullabor Plains
Great Southern Plain
Dundas Hills
Fraser Ra.
Fitz Gerald R.
Dover
Culver
Israelite Bay
Arid
Eyre Bird
To Adelaide
Mt Arthur
Mt Tuckfield
St Georges Ra.
Margaret R.
Denison Plains
Mt Elder
Mt Broome
Stokes B.
Mt Hamilton
Skirmish Hill
Mt Allott
Sutherland Ra.
Mt Destruction
Gibb Range
Mt Forrest
Mt Butler Fields
Alice Falls
Mt Deerway
Tom Price Ra.
Hamersley Ra.
Mt Sholl
Mt Nairn
Mt Harvey
Mt Dugel
Mt Gould
Mt Augustus
Mt Egerton
Mt Jones
Mt Stuart
Mt Robinson
Opthalmia Ra.
Mt Brockman
Mt Wittenoom
Mt Blair
Mt Bruce
Mt Narryer
Mt Vernon
Mt Hope
Sanford R.
Gascoyne
Carnarvon
Champion
Geraldton
Dongara
Arrowsmith
Greenough Flats
Tallering
Murchison
Gascoyne R.
Ashburton R.
Fortescue R.
Yule R.
Nullagine R.
Oakover R.
De Grey R.
Turner R.
Sherlock R.
Harding R.
Robinson R.
Lawley R.
Fraser R.
Broome
Roebuck Bay
Nickol Bay
Cossack
Roebourne
Port Hedland
Condon
Barrow
Monte Bello
Exmouth G.
Onslow
Cape Range
Yanrey
Northampton
Geraldton
Port Gregory
Irwin R.
Arthur R.
Greenough R.
Chapman R.
Murchison R.
Gascoyne R.
Wooramel R.
Lyndon R.
Minilya

and one particularly gigantic tree was 60 ft. around at the base." This wood is elastic and durable and much sought after for large planks. It is suitable for joiners' work, railway sleepers, furniture, cabinet work, &c. The porch to the West Australian Court was a notable feature in the display. It was chiefly formed of raspberry-jam wood, which is the popular name of the wood of the *Acacia acuminata*. The title has evidently been given it from its peculiar odour, which, when the wood is freshly cut, resembles that of the confection after which it is named. This is a very beautiful wood of a rich deep brown colour; it is very much used for cabinet-making and ornamental work generally.

Many of the woods of the colony are said to be admirably suited for wheelwrights' purposes, and several examples of naves, spokes, felloes, &c., were shown. Tuart timber (*Eucalyptus gomphocephala*) appears to be the most popular wood for these purposes. It is also very suitable for railway wagon building. The York local committee showed some shafts made from York gum (*Eucalyptus loxophleva*), a wood also much used for wheelwrights' work. The wandoo (*Eucalyptus redunca*) is also in request for wheelwrights' and railway wagon work. Another gum tree, the *Eucalyptus oleosa*, is notable from the oil that can be extracted from the foliage. This, it is said, is the best known solvent for amber and other fossil resins, and it is also well adapted for dissolving india-rubber. As a rule the eucalypts present but a sombre appearance. A brilliant exception, however, is the *Eucalyptus ficifolia*, which blooms about the month of February, when, as Von Mueller says, "brilliant trusses of flowers diffuse a rich red over the dark green foliage of the whole landscape."

The acacias are also valuable from an economic point of view. The *Acacia acuminata* we have already mentioned. The bark of *Acacia saligna* contains 30 per cent. of tannic acid, and the *Acacia microbotrya* yields large quantities of superior gum. Altogether more than 150 different acacias have been found in the hitherto explored parts of the colony. The application of many of these beautiful trees to ornamental purposes in Europe is well known. The beautiful scented sandal-wood (*Santalum cygnorum*) is another valuable product of West Australian forests. Examples of this were also shown at Messrs. Ransome's experiments. The Banksias also yield beautiful wood for ornamental work, whilst in the cypress pines of the north there is said to be a valuable stock of timber excellent for masts, spars, ships' decks, and building purposes. The resin from these trees may also prove of commercial value when attention is turned to its collection and export.

The mineral resources of the colony are practically all but undeveloped. Messrs. Gilchrist and Riley report that there are deposits of undoubtedly rich iron ores, some said to be almost inexhaustible in quantity. Up to the present, however, no workable coal has been discovered, a fact which at once discounts the value of the existence of iron. In the district around Northampton, near the Murchison River, some fine lodes of lead and copper have been found, and have been worked to a very limited extent. The low prices lately obtained for both these metals have doubtless checked the working, but should a demand arise at a paying figure no doubt the industry will become of some importance, as there is a railway connecting Northampton, which town is 34 miles inland, with its seaport at Geraldtown.

The metal which is attracting most attention in Western Australia at the present time, however, is gold. Our readers will doubtless have read in the daily journals of the excitement that has been caused by recent discoveries and the "rush" that has taken place to the Kimberley district. Up to the present date, the result has not had time to declare itself, but the hopes raised in the colony are very high. Mr. Alexander Forrest was the first to attract attention towards the auriferous nature of the Kimberley district. His report had the result of causing a Government survey party to be despatched in 1883, under the direction of Mr. E. T. Hardman, the Government geologist. In consequence of the want of a sufficient equipment the result was only partially successful, although gold was actually found. A second trip was made the following year, and the precious metal was found to exist in considerable quantities, some samples being shown in the late Exhibition. Mr. Hardman, in his report, stated that he "found gold to be distributed over about 140 miles along the Elvire, Panton, and Ord rivers, &c., as well as on the Mary and Margaret rivers, where the indications were very good, and the appearance of the country most favourable. . . . The gold-yielding country is well watered by numerous rivers, creeks, and gullies, which, even in the driest part of the year, are never wholly without water." In a paper read on this subject before the Geological Section at the last meeting of the British Association, Mr. Hardman said: "Miners were flocking to the new Eldorado in numbers from South Australia, Victoria, New South Wales, and the great mining colony of Queensland, and even from New Zealand. Two men from the latter colony obtained 1100 oz. and 300 oz. of gold respectively." According to a letter from the Surveyor-General, dated July 6 last, there must have then been nearly 3000 men on the fields. The event is of importance to the welfare of the colony to an extent far exceeding the mere value of the precious metal that may be obtained. What Western Australia has wanted has been population, and the thirst for gold will attract to its shores numbers of able-bodied men who would never have been tempted by the most bountiful promises of wealth to be won by the surer modes of more prosaic industries.

The cultivation of the vine is carried on to some extent in the south, there being, in 1885, 624 acres planted. Doubtless as the colony becomes more thickly peopled, the wine industry will be a leading feature of commerce. The same may be said of fruit growing, both climate and soil appearing to be favourable.

The northern half of the colony, or north of 28 deg. south, the country is devoted almost exclusively to pasturage. The wool exported in 1885 was, as we have stated, close on a quarter of a million sterling; and at the end of that year there were 1,702,719 sheep. The average price of the wool was 1s. per pound. The cereals are grown in the southern half of the colony, in which part there is also much pasture land.

With regard to cereals there were last year 77,728 acres under cultivation, and the yield per acre in 1885 was: Wheat, 11½ bushels; barley, 14½ bushels; oats, 14½ bushels; maize, 12½ bushels; hay, 1 ton; potatoes, 2½ tons. It is said that there is abundance of land suitable to the growing of cereals and other agricultural pursuits, and all that is wanted is that the country should be opened up and a population be found to carry on the industry.

The length of Government railway at present working in Western Australia is 124 miles. This comprises a line running between Fremantle, the port of Perth, and York, the distance being 90 miles, and the line of 34 miles between Geraldtown and Northampton, to which we have already referred. Twenty miles of railway are also in course of construction between York and Beverley; this, when completed, will put the latter town in communication with the capital and its seaport. The Government gauge is 3 ft. 6 in. A considerable extension of the railway system is contemplated by the Government, by which the existing lines will be increased by one-half. This will consist of seven miles between Roebourne and Cossack, 20 miles between Geraldtown and Greenough, 13 miles between Clackline and Newcastle, five miles between Spencer's Brook and Northam, and 20 miles in a direction starting from Bunbury towards Blackwood. The various timber companies have nearly 100 miles of railway or tramway for bringing their product from where it is obtained to the coast. The revenue received in 1885 from the 124 miles of Government railways was 27,179*l*.

The system of "land grant railways" has been introduced in Western Australia, and a contract has been entered into with Mr. Anthony Horndern to build a line 230 miles long to connect Beverley to Albany. Mr. Horndern contracts for his part to complete the line in seven years, to introduce 5000 immigrants, and to keep the line in working order when completed. In payment for this he is to have 12,000 acres of land for every mile of line completed; the line, however, remaining the contractor's property, the Government only stipulating for certain powers in regulating working. A contract of a similar nature has been entered into with Mr. John Waddington for the construction of a line 260 miles long between Guildford and Greenough. No doubt these lines when completed will give a great impetus to the development of the country, and for the present the price paid for them is cheap enough. On the other hand, it is worth considering how far the present legislators are preparing for future generations a new feudalism, with railway directors armed with bye-laws in place of barons equipped with sword and shield.

At the end of 1885 there were 2288 miles of telegraph lines, and 870 more were about to be erected; 500 miles being between Roebourne and Derby. The cost of sending ten words from any one place to another is 1s., with the exception of between Perth and Fremantle, where the charge is 6d. Compulsory education is the rule, Government schools existing in all settled parts. Denominational schools are also assisted by the State. With regard to shipping statistics, we find that during 1885 the number of ships outwards and inwards together numbered 461, carrying cargo to the extent of 468,035 tons. Of this number 229 were steam vessels. Steamers run monthly from Melbourne *viâ* Adelaide, and other ports, to Fremantle. The P. and O. Company's steamers arrive at Albany fortnightly from England, *viâ* Colombo, and from Sydney *viâ* Melbourne and Adelaide, making almost a weekly service from the more eastern colonies of Australia. In addition to this there are several steam coasting services. A public loan of 525,000*l*. has recently been raised for the construction of harbour works, railways, jetties, &c. The public debt at the beginning of 1886 was 1,288,100*l*., or 36*l*. 12s. 2d. per head of the total population. At the beginning of 1885 the total debt was 1,290,000*l*., made up of the following items: Railways, 826,065*l*.; telegraphs, 169,962*l*.; roads, 48,980*l*.; and other public works, 218,141*l*. The discount on sale of debentures amounted to 26,852*l*. The revenue in 1885 was 323,213*l*., and the expenditure 308,849*l*.

In addition to the above figures it may perhaps be interesting to add a few details of the average rates of wages for labour, as taken from an official publication. Farm labourers, ploughmen, &c., 15s. per week, shepherds and stockriders 40*l*. to 50*l*. per annum. These are with board, but the following are ordinary day wages: Masons, boat-builders, and carpenters, 8s. to 10s.; blacksmiths, saddlers, coachbuilders, and painters, 7s. to 10s.; printers 6s. to 10s.; tailors and shoemakers, 5s. to 7s.; brewers and navvies, 6s. to 8s. Female servants get from 16*l*. to 25*l*. a year, and married couples on farms and stations 50*l*. to 70*l*. a year with board and lodging. In looking through a list of local prices for provisions we notice that in most articles there is not a great departure from London prices, the most notable being butcher's meat, mutton being set down at 4d. to 6d. per pound, whilst beef and veal cost 4d. to 8d. Pork is dearer, the price being 6d. to 10d. per pound. We have no particulars of the cost of clothing and other necessities, products of manufacturing industries, but doubtless the prices would be considerably in advance of those ruling in this country.

It is claimed that Western Australia offers exceptional advantages to men of industry and enterprise possessing only small capital, as well as those having more ample means at their command. When the thinness of the population is considered, the favourable nature of the climate, and the many natural products awaiting the hand of man to develop them, no doubt the former claim will be generally allowed, and the latter to a great extent is a corollary of the first. Certainly, as the advanced eastern colonies of Australia become more thickly settled, and favourable land in them becomes more difficult to obtain, greater attention will be paid to the western district, vast tracts of which are now only awaiting the advent of civilised inhabitants to render them a source of wealth and comfort to the British Empire. Perhaps we cannot do better in concluding this brief notice of Western Australia than to condense some remarks from a paper read on the colony and its resources by the governor, Sir F. N. Broome, at a late meeting of the Colonial Institute. "The most pressing want, the one great need, is more people of the right sort; not only more hands to labour, but more capitalists to employ them. The development of valuable industries lying ready to hand is hampered at every turn by this want of population. The difficulty hitherto has been that our immigrants would not stay with us, but went to the wealthier and more bustling eastern colonies. Now this has changed, and the tide is setting the other way. Western Australia is bestirring herself, and a great deal has already been accomplished. Railways and telegraphs have been made. The annual income of the Government is very large, considering the

smallness of the tax-paying body, and is easily collected without undue pressure on any class. The people of Western Australia, if not wealthy, are in their smaller way a very comfortably well-off community. Every West Australian may have his fowl in the pot, and something more. The colony can boast many a substantial homestead, and even some rich men." This was written before the Kimberley goldfields came to the front. Possibly the simple claims here set forward would now be forgotten, and the humble boast of "the fowl in the pot" eclipsed by the more dazzling promises of the struggle for gold; not necessarily to the greater happiness and contentment of the colony.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(FROM OUR NEW YORK CORRESPONDENT.)

(*Continued from page 27.*)

THE session of the next day was held at the Stevens Institute, Hoboken. The first paper was that of your distinguished engineer, Mr. Benj. Baker, who came to our shores this fall for twenty-four hours; that must have been what he came for, because that was the only time he gave to us. The paper, however, made amends for this comet-like trip, and was entitled "The Working Stress of Iron and Steel." The author started with Rankine's factor of safety, which for ordinary steel was from 4 to 6 if subjected to a strain from a variable load, but the actual factor had been reached by a gradual strengthening of parts proved weak by experience.

In the case of the coupling-rod of a locomotive, failures having occurred in round rods, flat ones had been substituted, and the result is that when in the old form the stress was 17,000 lb. to the square inch, in the modern type it was about 8500 lb., and in this case the factor of safety is about 2. In the case of the Conway Tubular Bridge the extreme stress would be 20,000 lb. to the square inch, and the ultimate strength of the rivetted structure is 42,000 lb., yet no indications of weakness have appeared during thirty-six years. With a light girder and a small span such stresses would be destructive, so the Elevated Railway of New York has limited the stresses to 8000 lb. per square inch in the flanges of the girders, 7500 lb. in the web bracing, and 4500 lb. when alternate tension and compression occur. Engineers had learned by experience "that the strength of a structure or of a piece of mechanism cannot be determined by breaking a piece of the material in a testing machine, but it must be ascertained either by the gradual accumulation of the results of actual working or by testing the material under conditions as far as possible analogous to those obtaining in the case under consideration." As he desired to know more about the behaviour of modern structural steel under different stresses, he had made in the past few years a series of tests of which the Tables in the next column give the results. The spindles mentioned in the Tables were 1 in. in diameter, and projected 10 in. from the end of the revolving shaft; sixty to seventy revolutions were maintained day and night. The soft steel was fine rivet steel having a tensile strength of 60,000 lb. to 64,000 lb. per square inch, and an elongation of 28 per cent in 8 in. The hard steel had a tensile strength of double the above, and an elongation of one-half. The iron was best rivet iron having a tensile strength of 58,000 lb. to 61,000 lb., and an elongation of 20 per cent. Factor *a* is the ultimate tensile strength per square inch of the specimen divided by the calculated stress upon the outside fibres due to the load on the end of the projecting bar. Factor *b* is the ratio of the static load required to bend the bar a moderate amount beyond the elastic limit, to the load actually imposed on the revolving bar.

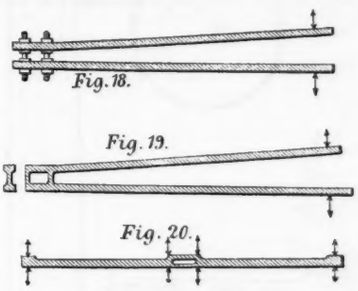


Fig. 18.

Fig. 19.

Fig. 20.

TESTS OF METAL.

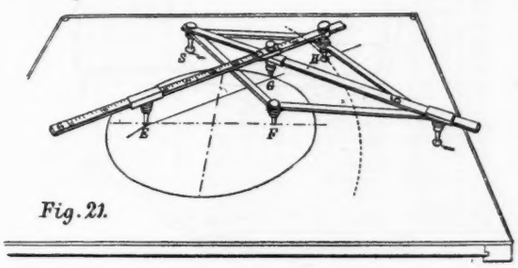


Fig. 21.

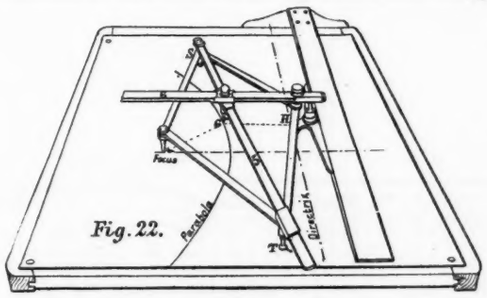


Fig. 22.

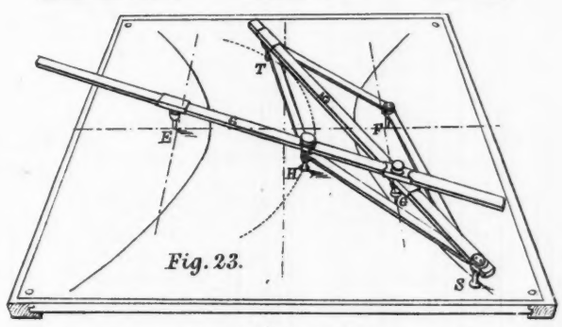


Fig. 23.

CAMPBELL'S CONIGRAPH.

No. 1.—*Rotating Spindles with a Weight at the Free End Causing Alternate Tension and Compression in the Fibres as the Spindle Revolves.*

Soft Steel.

Number.	Revolutions.	Stress Per Square Inch.	Factor *a*.	Factor *b*.
1	40,510	36,000	1.75	2.45
2	60,200	36,000	1.75	2.45
3	68,400	34,000	1.84	2.54
4	92,070	34,000	1.84	2.56
5	107,415	34,000	1.84	2.56
6	128,650	34,000	1.84	2.56
7	155,295	34,000	1.84	2.56
8	14,876,432	26,000	2.42	3.4
		Hard Steel.		
9	5,760	67,000	1 88	2.82
10	7,560	65,000	1.93	2 90
11	14,600	53,500	2.36	3.45
12	16,300	53,500	2.36	3.45
13	26,100	46,500	2.72	4.10
14	32,445	51,000	2.40	3.60
15	157,815	40,500	3.03	4.55
16	472,500	34,000	3.70	5.55
		Best Bar Iron.		
17	108,160	34,000	1.70	2.38
18	110,000	35,000	1.63	2.32
19	141,750	34,000	1.70	2.38
20	389,050	32,000	1.90	2.65
21	408,000	30,200	2.00	2.80
22	421,470	32,000	1.90	2.67
23	480,810	31,000	1.95	2.75

No. 2.—*Flat Bars Bent in some Cases One and in others Both Ways.*

Soft Steel.

No.	Bends.	Stress per Square Inch.	Factor *a*.
24	12,240	44,000	1.59
25	12,325	44,000	1.59
26	12,410	44,000	1.59
27	18,100	42,000	1.67
28	18,140	42,000	1.67
29	72,420	36,000	1.94
30	147,390	34,500	2.03
31	262,680	34,000	2.05
32	1,183,200	27,500	2 55
33	3,145,020	34,500	2.03
		Best Bar Iron.	
34	184,375	34,000	1.68
35	250,513	34,000	1.68
36	3,145,020	34,000	1.68

The flat bars were usually 1 in. wide and ½ in. thick with 32 in. between bearings. The steel came from the tension member plates of the Forth Bridge, and had a tensile strength of 70,000 lb. to square inch, and an elongation of 20 per cent. in 8 in.

The iron specimens were rolled bars. Comparing 8 and 14 in No. 1 where the working stresses are 40 per cent. of the ultimate strength, it appears the hard steel failed with 32,445 revolutions, while the soft steel stood 14,876,432, and in case of 16 and 23 the hard steel, though possessing more than double the tensile strength of the iron, broke under a working stress of only 10 per cent. greater. These results show that ordinary laboratory tests are not an adequate measure of the value of a metal as a material of construction. These experiments did away with that idea of some engineers, that alternate stresses are only destructive when the elastic limit is exceeded, because none of them exceeded this limit, and some were far below it; in the case of 16 it was only one-seventh of the original static breaking load. It also appeared from these experiments that a structure or piece of mechanism may be subjected to a repeated stress of 90 per cent. of its breaking weight, and yet pieces taken from it show no signs of deterioration. Hence the author concluded it was hopeless to expect to learn much from testing specimens of metal from structures or machines which have been long in use. His experiments had fully confirmed the opinion of M. Considère as regards rivetted joints: "In all constructions in which the rivetted portions have not already commenced sliding, the rivets work solely by longitudinal tension, and the adherence which this tension gives rise to between the plates in contact constitutes the sole resistance; any alternating stress in excess of that adherence rapidly dislocates the work."

The author, by testing plates in ordinary con-

KEMP'S HIGH AND LOW TEMPERATURE BOILERS; S.S. "BLÉVILLE."

CONSTRUCTED BY MESSRS. ALEXANDER STEPHEN AND SONS, ENGINEERS, LINTHOUSE, GLASGOW.

(*For Description, see Page* 54.)

Fig. 1.

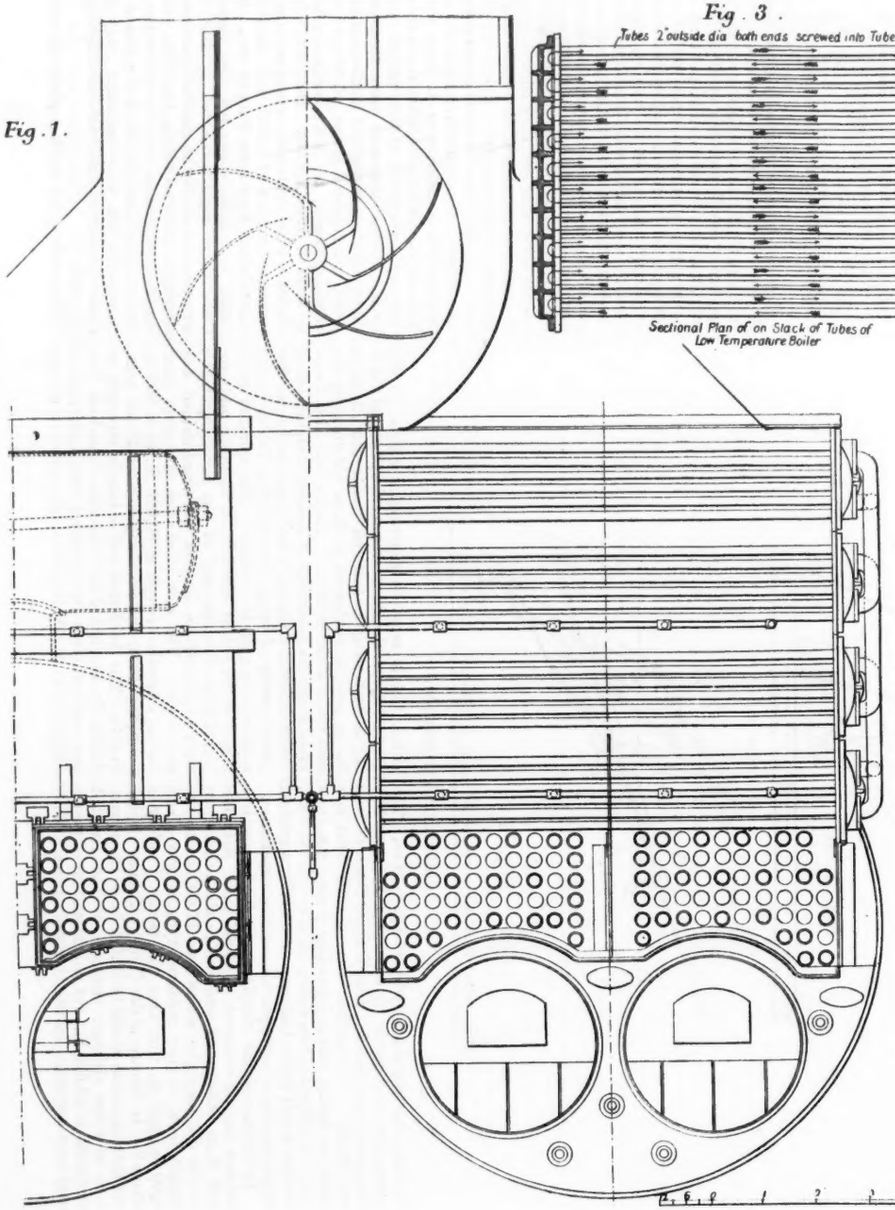


Fig. 3.

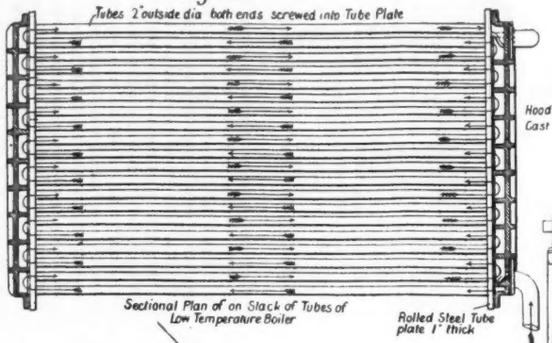
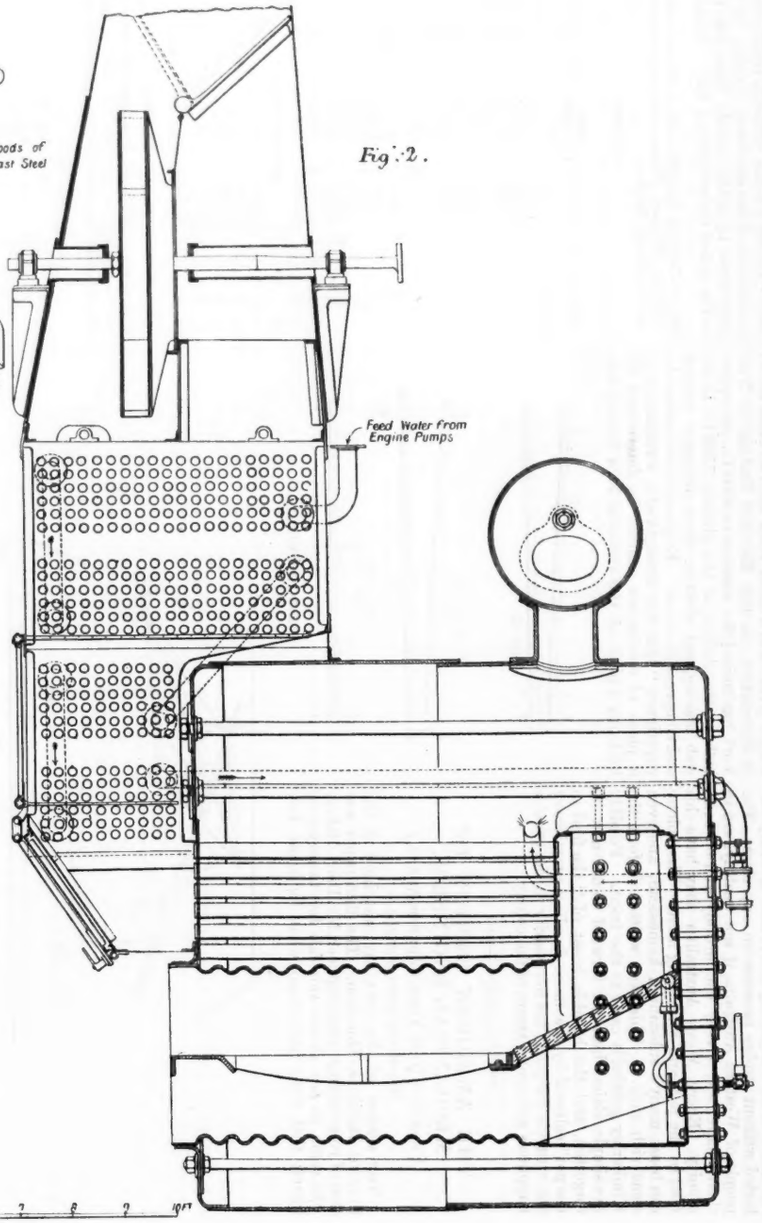

Tubes 2" outside dia. both ends screwed into Tube Plate
Hoods of Cast Steel
Sectional Plan of on Stack of Tubes of Low Temperature Boiler
Rolled Steel Tube plate 1" thick

Fig. 2.



KEMP'S HIGH AND LOW TEMPERATURE BOILERS; S.S. BLÉVILLE.

CONSTRUCTED BY MESSRS. ALEXANDER STEPHEN AND SONS, ENGINEERS, LINTHOUSE, GLASGOW.

(*For Description, see Page* 54.)

Fig. 4.

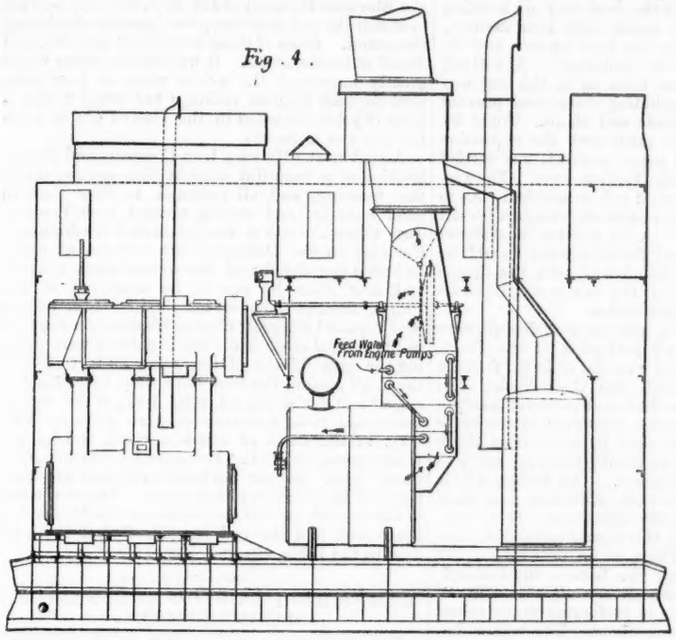


Fig. 5.

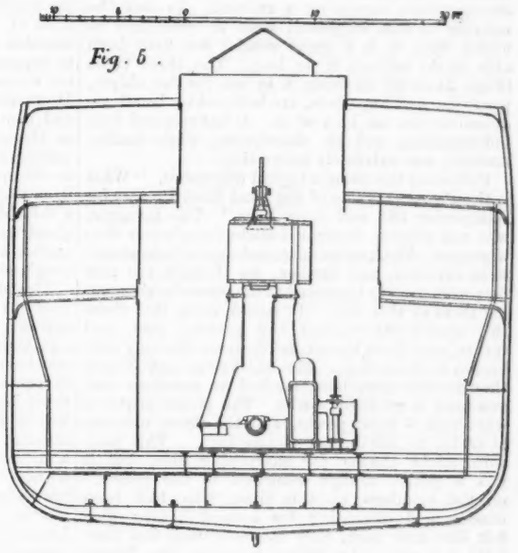
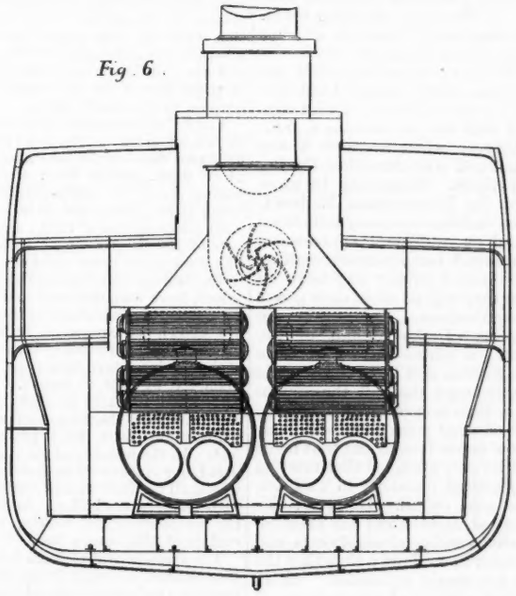


Fig. 6.



dition, secured with bolts screwed up to a known tension, found the coefficient of friction averaged one-third, but if the soft steel rivet was closed up under hydraulic pressure it had an increased ultimate strength of 10 to 15 per cent., and an elastic limit of 45,000 lb. to the square inch.

In order to ascertain whether alternate stresses were prejudicial to members like piston-rods subjected to direct pull and thrust, or like shafts to transverse bending, the author instituted the tests given in No. 3:

SERIES No. 3.

Soft Steel.

	Number of Bends.	Stress per Square Inch.	Factor *a*.
Fig. 18.	28,008	37,000	1.90
	49,320	38,000	1.84
Fig. 19.	11,880	28,000	2.50
	29,568 (hard steel).	16,700	4.90
Fig. 20.	230,513	35,000	2.00
	294,735	25,000	2.80

Other experiments were made, but the above are sufficient to prove that alternating stresses are at least as prejudicial when the stresses are direct as when they are indirect. In the first, the pieces of metal tested were sometimes of round and sometimes of flat cross-section, and were bolted to a couple of spring bars, as shown in Fig. 18; the stress being applied by opening and closing the legs of the tongs, and thus putting the metal into alternate tension and compression. In the second group the spring bars and specimens were all sawn and slotted out of one piece of steel, and the necessity of constantly tightening up the nuts was thus avoided (Fig. 19). In the third the specimens were shaped as shown by Fig. 20, and a bending stress applied at the centre of the bars.

In regard to tests in full-sized rivetted girders the author had noted the influence of varying stresses. In one instance the lever of a large plate bending press of box girder section and built of eight 4 in. by 4 in. by $\frac{5}{8}$ in. angle bars, two 13 in. by $\frac{3}{4}$ in. rivet plates, and two 17 in. by $\frac{1}{2}$ in. by $\frac{5}{8}$ in. flanges, having a span of 15 ft. 8 in., and daily working stress of from 43,000 lb. to 57,000 lb. to the square inch, had taken a permanent set of $\frac{7}{8}$ in., but otherwise was intact.

Mr. Baker thought the old Government regulations giving the same limiting stress for all kinds of loading and the modern formulæ based on Wöhler's experiments, do not meet the requirements of the practical engineer. He thought in some instances it was better to face the fact of occasional breakages than to attempt to give the strength necessary to insure absolute durability. When the stress alternates from tension to compression large rivet area must be provided, as a very few repetitions will loosen the rivets; when metal is subjected to compressive strains only of varying intensity he has been unable to detect deterioration. He considered a machine or a bridge could only be well proportioned by carefully considering the special conditions of the case in the light of experimental data and past experience. He remarked: "A string of formulæ will not make an engineer;" to this the writer gives a hearty "Amen." It is sad how many men fail to realise the truth of Mr. Baker's remark; if they did, the mathematical gymnastics indulged in by some would be a thing of the past. Mr. Baker concluded this able and interesting paper by eulogising mild steel as a material to be preferred to wrought iron.

Professor Wood, in discussing this paper, agreed largely with Mr. Baker, but cited cases to prove that straining beyond the elastic limit slightly would not hurt the metal, although there was a limit. Mr. Kent drew from Mr. Baker's paper the conclusion that for the successful sustaining of repeated strains within the elastic limit, medium hard steel was preferable to soft steel, and in this connection referred to an article by Captain Metcalfe, one of our most eminent investigators in the Ordnance Service, published nine years ago, corroborating this view.

The next paper was by Mr. William Kent, entitled "Is Water Gas an Economical Fuel." He did not think it as economical as Siemens gas for steel-melting furnaces, and claimed that previous investigators had not considered the loss due to the carrying away of heat in the superheated steam in the chimney gases, which he estimated at 11 per cent. of the total fuel value of the carbon used, and this was independent of any loss arising from imperfections of the producer or its method of operation. In the discussion several members indorsed Mr. Kent's views, and he admitted that

for a small plant water gas did possess some advantages of the Siemens.

The "new conigraph," an instrument for drawing conic sections, was shown and described by Mr. Andrew C. Campbell. He thought it would prove valuable in laying out elliptical gearing, and others saw a use for it in glass cutting. One member believed it could be used in laying out parabolic curves on a railroad. In fact the number of uses suggested were so great and so varied that it is a great wonder we have been able to do without it so long. The three views (Figs. 21 to 23) showing it in use for the ellipse, parabola, and hyperbola, are believed to be all required to give an idea of it. It has received high indorsements, and its description, while mathematical, was extremely interesting.

Following this came a topical discussion, "What is the Practical Value of the Sand Blast Process for Sharpening Old and New Files." The inventor, who was present, thought it made them better than when new. Much enthusiasm is always to be conceded to an inventor, and further, he thought the new files were greatly improved at the outset by sharpening them in this way. It would seem that these two statements covered the present, past, and future, and those three conditions are the only ones known to the writer. Messrs. Frome and Taylor thought the sand blast method an excellent one, and used it in their works. The power required was about 6 horse-power, and the steam pressure at 60 lb. to 100 lb. per square inch. This pressure might answer for sharpening files, but it was a gentle zephyr compared to the pressure on the members at this time, who had been cussing and discussing for several hours; they felt like new men, and the new man was fearfully hungry. Our fellow member, Dr. Henry Morton, was aware of this tendency among Mechanical Engineers, for he had most hospitably entertained them on a former occasion; but Dr. Morton's hospitality is very much like his many and valuable searches in the fields of science, and knows no limit, so the Society were feasted at his house in a manner that threatened to stop all afternoon discussions. But Mechanical Engineers have a large "factor of safety," and their "elastic limit" was not overstrained, so enough were persuaded to leave their comfortable quarters at Dr. Morton's, and resume their afternoon's work.

The first paper was on "Fire Boats," by William Cowles.* The paper contained a description of the Seth Low, the Cleveland, and the Geyser. It was accompanied by a table contrasting these boats and your English one called the Merryweather. The author advocated the use of 2½ in. and 3½ in. streams on account of their ability to tear through walls and partitions into the heart of a fire and break it up, so that smaller streams will become efficient. The author adopted the ordinary Scotch boiler because of its lightness. He considered the main features of a fire boat to be the boiler and the pumps. As the boats were not designed for sea service, it was permissible to carry the water line higher, and use a dry pipe. A ratio of 38 to 1 between the heating and grate surface was used on account of having a forced draught. The weight is further reduced by using only the best grade of material and cutting out the useless and "dead" water spaces below the furnaces by putting in extra fire-tubes, and a regenerating flue for admitting heated air into the back connection. As to speed, the Geyser, on Lake Michigan, in a rough sea, made 4 knots in 15 minutes by taff-rail log, or at the rate of 18⅔ knots per hour. (The writer would state he has seen as large waves on Lake Michigan as he ever saw in a three days' storm in the Atlantic.) The Cleveland in extremely rough weather and in a shifting wind made 10½ knots per hour, and turned in a circle of 135 ft. diameter in 1 minute and 33 seconds. The Seth Low has made 12.8 miles in an hour.

"Casting Aluminium Bronze and other Strong Metals," by Thos. D. West, was the next paper. The great difficulties to be overcome are the evils due to oxidation, shrinkage, and contraction. In aluminium bronze the evil of shrinkage was overcome by having the "risers" larger than the body or part of the casting they were intended to feed, and by "gating" a mould so that it would be filled as quickly as possible, and by having the metal as dull as it will flow and make a full run clean casting. The author thought the methods of casting were improving so rapidly that the engineer should not want for strong metals. In regard to the topical question as to whether aluminium bronze was corroded by exposure to the weather, it was settled that it was not. It was settled as to which was preferable, a feed pump or an injector, that both were necessary. As to the best way of building annealing furnaces for small grey iron castings, the advantage of having the heat on top and the flues at the bottom was conceded. A settling chamber settled the next topic as to the best way to separate grit from grinding rooms and prevent its dissemination in yards and shops. Topic 33. How may drawings be made and the expansion and contraction of the paper avoided, was settled as Alexander settled the Gordian knot. The prevailing opinion was, it could not be avoided. As to to the query, "How can intricate templets be cut from very thin metal." A jig saw was considered a valuable auxiliary, and the thin metal should be glued to two pieces of thin board with the design pasted on the top, then the saw would leave no rough edge on the metal templet.

This closed the session, and the next day all were ready to accept the kind invitation of the Pennsylvania Railroad to take a special train to Trenton and visit Cooper, Hewitt, and Co.'s Works. As usual the Pennsylvania Railroad is never wanting in courtesy to engineers; whenever or wherever there is a body of these men in convention there will be found the Pennsylvania Railroad ready to assist in their entertainment. The writer, who is a member of four scientific societies, can bear witness to this on many occasions. It is also gratifying to know that this liberal spirit has been met by a response. There is no railroad in the United States which has the friends the Pennsylvania Railroad possesses. Every engineer will not only go over their route in preference to any other, but will send his friends there. The writer has spent time in persuading travellers, especially your countrymen, not to go West by any other route. This action of the Pennsylvania Railroad, who has the very best equipped and operated line in the world, is in a most striking contrast to that of the Erie Railroad, who have never extended but one invitation, so far as the writer knows, to visit anything they own, and that was to examine a grain elevator in Jersey City, on which occasion it was the Pennsylvania Railroad who furnished the tug that took the party there. There may be great policy on the part of the Pennsylvania Railroad, but the writer believes that their courtesy is dictated by a kindly spirit and an intelligent appreciation of the value to all railroad management resulting from the ideas interchanged among engineers on such occasions, hence they will do all in their power to encourage such gatherings. Two years ago there was a gathering of the alumni of the Rens. Poly. Institute, a school second to none for educating civil engineers, and the Pennsylvania Railroad promptly announced that all the alumni would be carried from their homes to Philadelphia, and return over any of their main or leased lines, without charge. How many friends did that make for them? No one who ever attended that meeting will ever forget the repeated allusions to this act, and the effect it produced on all. However, this was the means to the end, and the end was Trenton. We took the commodious and comfortable cars, and were whirled to Trenton in so short a time that the supply of cigars was not nearly exhausted. As an instance of the perfect system of this railway, it may be noted that when the writer asked the superintendent of the New York division at what hour it would be convenient to take the party, the answer was "At any time they desire to go;" and when, after the visit, the station agent at Trenton was asked how soon the train could be hauled back to New York, his answer was the same, "As soon as your cars come down from Cooper, Hewitt, and Co.'s siding, there is the engine waiting," and it was so, in spite of their fast trains, their limited expresses, &c., our advent on their line caused no more sensation than the fly on the bull's horn. The Trenton trip was a great success; Cooper, Hewitt, and Co. had our train hauled up their siding about 1½ miles, and showed their rolling mills, where 20 in. beams were rolled, and then their bridge works adjacent. The most interesting mechanical tool was a drill for making rivet holes. The Society was then taken to the wire mill, and dined in a most satisfactory manner; afterwards they were shown through it, and a Corliss engine, running 1200 ft. a minute, was not the least interesting object to many. Thence the cold-drawing works were visited, and the ladies taken to the Trenton Potteries.

The interesting shop of Fisher and Norris, where the best anvils in the world are made, were inspected, and the famous Fisher rail joint was carefully examined, which has proved such a success on the Elevated Railroad of this city, not only serving to stiffen the rail structure, but greatly deadening the sound. Some of these introduced into England would not come amiss. It was the one thing which greatly impressed the writer when on your side, that the best English railways are using to-day a form of joint discarded in the United States some ten years or more ago.

A visit to the Phœnix Iron Company and the exhibition of a beautiful straight line engine, closed this meeting, and all returned to New York in good humour, and greatly pleased with Trenton. Just above the city is the celebrated Washington's Crossing on the Delaware, the pictures of which had been the delight of the writer when a child, and now when he saw it, he wondered at two things, first, at the great imagination of the painter who depicted the great George Washington wrapped in his martial cloak while his assistants were pushing the great blocks of ice, some 50 ft. to 100 ft. thick, all around the frail boat they threatened to engulf; and the second was, why, if he was in haste and your countrymen were pressing him, why, in the name of common sense, did he not jump across, unless the Delaware has shrunk since those days. So our boyhood's illusions are shattered in the realities of late years. This is the end of the seventh annual Convention of the Mechanical Engineers, and the end was like that of the good man in the Bible, the end was peace.

* We published this *in extenso* last week.

KEMP'S HIGH AND LOW TEMPERATURE MARINE BOILERS.

SOME weeks since we mentioned a few particulars regarding a novelty in marine boiler construction, the testing of which had then just taken place in connection with the trial trip of the screw steamer Bléville, a vessel built and engined by Messrs. Alexander Stephen and Sons, of Linthouse, Glasgow. We now illustrate on pages 52 and 53 the boilers just referred to, and propose to describe it fully.

The Bléville is a steel cargo steamer built for Mr. C. Brown, of Havre. She is a vessel capable of carrying 3800 tons deadweight, and measures 300 ft. by 40 ft. by 24 ft. 6 in., and is fitted with water ballast. Her engines are of the triple-expansion type, the cylinders being 21 in., 33 in., and 52 in. in diameter respectively, with piston stroke of 42 in., and a working steam pressure of 160 lb. per square inch. The cylinders are in line working on three cranks.

The boilers, which constitute the novel feature of the vessel, have been designed and patented by Mr. Eben. Kemp, one of the partners of the builders' firm, and they are known as compound high and low-temperature boilers. There are two of them, and primarily they are of the marine return-tube type, measuring 10 ft. 7 in. in diameter, by 10 ft. in length. There are two of Fox's corrugated furnaces in each, 3 ft. 6 in. in diameter; and the total heating surface is 1768 square feet, while there is a total grate surface of 72 square feet. In the uptakes of each of these boilers there are fitted four stacks of 2-in. tubes, 9 ft. in length, through which all the feed water circulates before it reaches the high-temperature boiler. In these tubes, which form the low-temperature boilers, there is a total heating surface of 3392 square feet.

The arrangement of these tubes is indicated in the illustrations, on pages 52 and 53. It will be observed that the two lower stacks of the tubes are placed in the smokeboxes, close down to the tubes of the high temperature boiler. From the sectional plan (Fig. 3) of one of the stacks of low-temperature tubes, it will be seen that the ends of the tubes are screwed into steel tube-plates, over which are fitted cast-steel hoods having vertical ribs bearing against tube-plates, between the alternate rows of tubes, for circulating the water. The water enters by a pipe at one end of the top stack, passes through one vertical row of tubes, returns through the next, and so on till it reaches the endmost row. Then it passes by a pipe to the stack of tubes immediately underneath the first, and ultimately it enters the high-temperature boiler by a check valve by which the flow is regulated in the ordinary way. The heat of the gases in the uptake is in this manner very fully taken advantage of. The comparatively cool feed water from the hot-well first meets the gases at a reduced temperature, and as it rises in temperature by absorbing heat, it meets the gases at a relatively higher temperature, and is thus able to absorb more heat. It finally leaves the tubes at that point in the smokebox where the effluent gases are the hottest.

By way of testing the efficiency of these arrange-

ments at the various trials to which they were subjected, thermometers were fitted to the feed pipes, and while the inlet from the hot-well showed about 120 deg. Fahr., the outlet where the water passed into the high-temperature boiler indicated about 360 deg. A pyrometer was inserted into the smokebox across the ends of the fire tubes, and while it registered about 650 deg. Fahr., another pyrometer, placed just above the low-temperature tubes, registered about 300 deg., thus showing approximately how much of the heat which would otherwise have gone to waste was utilised.

In order to test the amount of resistance caused by the long stretch of pipes through which the feed water has to pass, a pressure gauge was placed on the feed pipe communicating with each boiler, between the pump and the low-temperature boiler. The gauge in each case showed that with each stroke of the pumps the pressure was raised about 4 lb. or 5 lb. above the pressure of the steam gauges of the boilers—the resistance being thus practically *nil*.

For the purpose of developing an extra amount of horse-power when desired, or to improve the draught in calm or tropical weather, or when burning inferior coals, a fan is fitted in the uptake above the low-temperature tubes. It is 6 ft. in diameter, and is driven direct by means of a small engine placed in the engine-room. The position of this fan is indicated in Figs. 1, 2, 4, and 5. Both the fan and the engine for driving it were supplied by Messrs. W. H. Allen and Co., London. This arrangement of fan proved highly satisfactory—a pressure in the funnel equal to 2 in. of water being obtained with about 500 revolutions per minute. This pressure, however, is much in excess of what was wanted—$\frac{1}{2}$ in. or $\frac{3}{4}$ in. being all that is likely to be required in regular practice. A valve is provided above the fan, by means of which the smoke can be passed either through the fan or straight up the funnel by natural draught.

With the view of testing the coal consumption as in ordinary working at sea, the engines of the Bléville were run at the rate of 60 revolutions per minute, maintaining a speed of about 10$\frac{1}{2}$ knots per hour. Both boilers were used with natural draught. The coals were measured during a six hours' run, and the amount burned was equal to 11.4 tons per day, nothing being deducted for steam used in the steering gear. A run was also made with a single compound boiler, the fires of the other having been drawn. With moderate forced draught (about 1 in. of water) a speed of 10 knots was kept up, and even with natural draught a single boiler provided a sufficiency of steam pressure to drive the ship at a speed of about 8$\frac{1}{2}$ knots per hour. It was thus seen that the vessel could be driven at her ordinary speed at sea with one of the compound boilers, by resorting to the moderate use of the forced draught. With both boilers working under moderate forced draught 1223 horse-power was indicated, with 70 revolutions of the engines, which maintained a speed of 11$\frac{1}{2}$ knots per hour. Under these conditions the boilers were found to be capable of producing more steam than the engines could use. The pyrometer in the smokebox during the forced draught runs was found to indicate occasionally as high as 1050 deg. Fahr., while that above the tubes at the same time showed a temperature of 350 deg.

On the passage of the Bléville to Havre from the Clyde the coals were measured all the way, and the consumption was equal to 10$\frac{1}{2}$ tons of Scotch coals per twenty-four hours—the speed of the vessel averaging 10 knots.

A sister ship—the Greville—lately built by Messrs. Stephen and Sons, having compound engines and ordinary boilers, and carrying rather less deadweight, burns about 17 tons of Scotch coals at sea per twenty-four hours on the same speed. Besides this great economy in the daily consumption of coal, a further economy is gained to the shipowner by the fact that the triple-expansion engines and compound boilers of the Bléville, while capable of developing more power, occupy 2 ft. less space fore and aft in the ship, than by the older type of engines and boilers in use in the Greville.

It is scarcely necessary to go into any description of the details shown in the sectional plans of the Bléville through the engines and boilers (Figs. 4, 5, and 6 on page 53), as they explain themselves.

STREET PAVING IN PARIS.

IN the session of the Paris Municipal Council on Thursday, December 9th last, M. Alphand, Director of Public Works, in the course of a discussion relative to the city finances, thus expressed himself concerning experiments in paving the streets of Paris.

"Ought we to maintain stone pavements, laying them on concrete, sand, or any other substratum? Ought we to prefer asphalte or wood paving rather than stone?

"All systems have had a trial; but the experiments have not been long enough to enlighten us exactly as to their value. If you were at present to undertake the 75,000,000 francs worth of paving which is under consideration, you would run the risk of doing defective work, and of having to begin over again, in a few years, all that you had done.

"Let us see in the first place if ordinary paving on concrete is advisable.

"When this idea first saw the light, it was enthusiastically welcomed. It was even pretended that the paving engineers of Paris were far behind the times. I see before me an eminent engineer, ardent partisan of paving on concrete, who will not contradict me.

"Well, gentlemen, the experiments undertaken did not succeed. In the Rue Saint-Lazare a trial was made; on hard concrete bed a pavement of Yvette stone was laid down. What happened?

"The stone pavement weighing upon the concrete, the concrete pressing against the pavements, the pavements communicating with the houses, the result was an enormous hubbub in the streets and a continual shaking of the houses.

"Furthermore, the pavement, between the concrete and the carriage wheels, was as if between anvil and hammer. It gave way, and we are convinced that this kind of pavement cannot be laid down upon a bed of concrete. And yet, in this experiment, we had used the Yvette stone, the good qualities of which you admit, and not the porphyry pavement to which you object.

"After this, we thought that it was better to have a certain elasticity to the pavement, and that we could obtain this by placing a layer of sand between the concrete and the paving stones.

"This is the experiment which we are now trying on the Rue de Rivoli. We have just now every reason to hope for a good result. But it is not yet the perfect, the ideal street, such as the wooden pavement would give us.

"Now, gentlemen, I reach a point which I consider very important. I wish to speak of the examination of the results of the wood paving. These results, I am happy to say, have, up to date, exceeded our expectations. In streets where there is not much traffic, where the circulation is small, the repairs of the wood pavement will be, it appears, much less than the estimated sums.

"I must add that, for a long time, it was feared that the wooden pavement could not be used on streets where there are tramways. This was simply a mistake. We have made trials on the Rue Lafayette, Boulevard du Palais, and Place de la Concorde. The results obtained were stupefying. The tramway rails seemed to disappear; the shaking no longer exists.

"Here, gentlemen, we are in presence of a new, important fact, an experiment which must be prolonged, and at the end of which, perhaps, we shall discover the veritable solution of the paving question.

"But, as I have already told you, we are as yet only in the experimental period.

"The time is, therefore, still comparatively distant when you will have to take sides on this great question, and decide on the expenditure of the many millions of which I have spoken. Now, before that time, I am convinced that you will see money easier for appropriations, thanks to the loan which you have just voted, and which will reopen the era of the great public works.

"And let no one say that I am led away into vain optimism. I find the proof of what I predict in the last statements of your octroi receipts. A deficit seemed inevitable for 1886; we shall have an equilibrium between the estimates and the receipts. And this increase in octroi receipts dates from the moment when the Council opened the first credit of twenty millions from the loan funds.

"I hope that next year, with the 40,000,000 which you will place at our disposition for extraordinary operations, we shall see our receipts still further augmented, and our budget sufficiently balanced, so that we may securely plan the great work of the transformation of the paving of Paris."

In the session of the Conseil Général of the Department of the Seine, on the 27th of December, 1886, the following resolution was passed:

"The alterations mentioned in the resolution of the Conseil Général passed on April 17, 1885, relative to the application of wooden pavements on bridges, and in those portions of the public streets in front of municipal edifices, hospitals, &c., shall be carried out according to requirements and the resources available.

"The substitution of wooden for stone pavements shall be made on bridges in masonry as well as on metallic bridges."

LAUNCHES AND TRIAL TRIPS.

IN the early part of this month, prior to taking up her berth on the Thames, where she arrived on Tuesday, the 11th inst., the new Orient liner Ormuz had her speed trials on the Clyde. She was built and engined by the Fairfield Shipbuilding and Engineering Company, and is a steel steamer of 6116 tons gross register, with a displacement of 10,500 tons at 26 ft. load line; she measures 465 ft. between perpendiculars, by 52 ft. by 37 ft., and has been specially designed and equipped for the Orient Steam Navigation Company's service between London and Australia. Her engines are of the triple-expansion type, with cylinders of 46 in., 73 in., and 112 in. in diameter respectively, and piston stroke of 6 ft. There are seven cylindrical steel boilers, of a working pressure of 150 lb. per square inch. The Ormuz has a double bottom, with fireproof and water-tight bulkheads, including one which divides the boiler space into two, so as to secure the ship against having all her fires extinguished and being rendered helpless. There are five decks. The double bottom is divided into water ballast compartments, each holding many hundreds of tons, so that as the coals are consumed the ship can be kept immersed to the degree found to be most comfortable and satisfactory. All the public rooms, passages, steerage, &c., are lighted by electricity, and there are several arc lamps for lighting the engine-room and other parts of the ship. The passenger accommodation is admirable in every respect and very extensive. Hydraulic power is used for working the steering gear, &c. On her trial trip on the Clyde the Ormuz developed a speed of 18 knots per hour.

On Tuesday, January 11, the London and Glasgow Shipbuilding and Engineering Company launched a steel screw steamer named the Glenshiel, a vessel of 3455 tons, and measuring 370 ft. by 45 ft. by 34 ft. 6 in. She is owned by Messrs. M'Gregor, Gow, and Co., of London and Glasgow, and is to be engaged in the China tea trade, like her sister ship the Glengyle, which was built last year. The builders are supplying the engines, which are of the triple-expansion type, and of 3000 indicated horse-power.

Messrs. M'Knight and Co., Ayr, on the same day, launched a paddle tug steamer named The George Brown of Irvine, built to the order of the Irvine Harbour Trustees. She is a vessel of 98 ft. by 18 ft. by 9 ft. 2 in., and is being fitted with surface-condensing engines by Mr. William Kemp, Govan.

On the following day Messrs. Alexander Stephen and Sons, Linthouse, near Glasgow, launched the Queen Victoria, a steel screw steamer of 2400 tons, built to the order of Messrs. Thomas Dunlop and Sons, Glasgow, and to the highest class at Lloyd's. She is fitted with a double bottom throughout on the bracket principle, capable of holding 455 tons of water ballast, and she has five water-tight bulkheads, 'tween decks of steel, and main deck of steel covered with yellow pine and teak. The vessel has been fitted by the builders with triple-expansion engines having cylinders of 20 in., 33 in., and 51 in. in diameter respectively, the length of piston stroke being 42 in., and with steel boilers designed for a working pressure of 160 lb. per square inch.

On Thursday, January 13, Messrs. Lobnitz, Renfrew, launched a large twin-screw pontoon ship, which has been built to the order of the Panama Canal Company. The pontoon measures 100 ft. by 40 ft. by 14 ft. It is fitted with engines capable of steaming the vessel to her destination, and with three cranes, one of them capable of lifting 20 tons.

On Thursday, the 13th inst., Earle's Shipbuilding and Engineering Company (Limited) launched from their yard at Hull an iron screw steamer named the Auckland, which they have constructed to the order of the Humber Conservancy Board for salvage and towing purposes in the Humber and neighbourhood. The dimensions are 132 ft. by 22 ft. by 11 ft. 6 in., and the vessel is built to Lloyd's highest class of steel, the scantlings being considerably in excess of rule. Large catheads are built into the ship at each end for taking heavy lifts, and bitts and fairleads on the deck are also of ample size. She will be rigged as a fore-and-aft schooner with two pole masts; the rigging, derricks, &c., are all very efficient, and specially suited to the work that will be required of them. Powerful pumps are fitted in the engine-room with large deck connections for salvage purposes. She will be fitted by the builders with compound engines of 300 indicated horse-power, having cylinders 18 in. and 36 in. in diameter by 21 in. stroke, which will be supplied with steam from a large steel boiler made for a working pressure of 90 lb. per square inch.

Messrs. Russell and Co., on Friday, the 14th inst., launched from their Greenock shipyard the largest sailing ship ever built at that port. She is named the Drumcliff, and is a four-masted vessel built to the order of Messrs. Gillison and Chadwick, Liverpool. She measures 310 ft. by 43 ft. by 24 ft., and is a vessel of 2500 tons net register, with a carrying capacity of considerably over 3000 tons.

On Saturday Messrs. A. Philp and Son, of Dartmouth, launched a steam yacht of 120 tons, built to the order of Mr. F. C. Capel, of London.

THE ANGLEUR STEEL WORKS.—The Bessemer and Thomas foundries of the Angleur Steel Works Company produced, in 1885-6, 37,553 tons of rough steel ingots. In the same period, the works also turned out 29,313 tons of finished steel products, such as rails, sleepers, tyres, forgings, &c. Rolled wire was made to the extent of 4751 tons, and pig and castings to the extent of 36,820 tons. The net profits of the year, after providing for obligation interest, are returned at 5237*l.*, but no dividend is proposed for the twelve months.

MANUFACTURING SMALL BELLS.—Among the many articles which have been cheapened by the use of presses and dies may be mentioned small bells for household use, telephone calls, &c. They were formerly cast and the castings turned or ground, requiring quite an expenditure of time to produce the finished article. It has been found that ordinary sheet brass, when formed to proper shape, is quite as resonant as cast bell-metal. Bells can be produced at a single stroke of a press as fast as the metal can be fed, averaging from 25 to 50 per minute, and the surface and edges being smooth require but little polishing. The Ferracute Machine Company of Bridgeton, New Jersey, U.S.A. (who make a specialty of presses and dies for sheet metal), have furnished several outfits to manufacturers for this purpose.

BRIDGES ON THE EASTERN AND MIDLANDS RAILWAY, CROMER EXTENSION.

MR. WILLIAM MARRIOTT, ENGINEER.

(*For Description, see opposite Page.*)

Fig. 5.

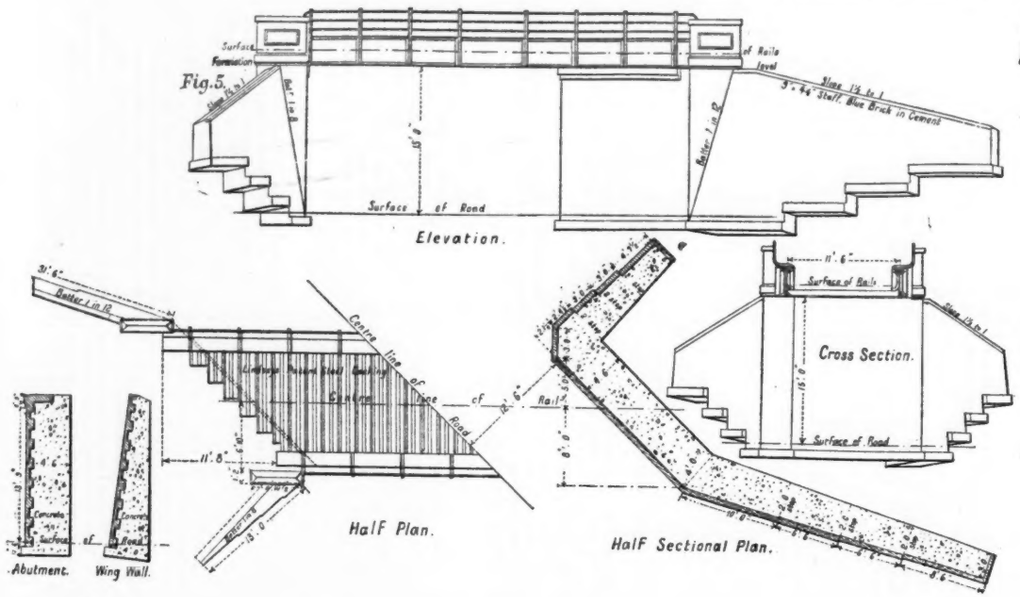


Fig. 9.

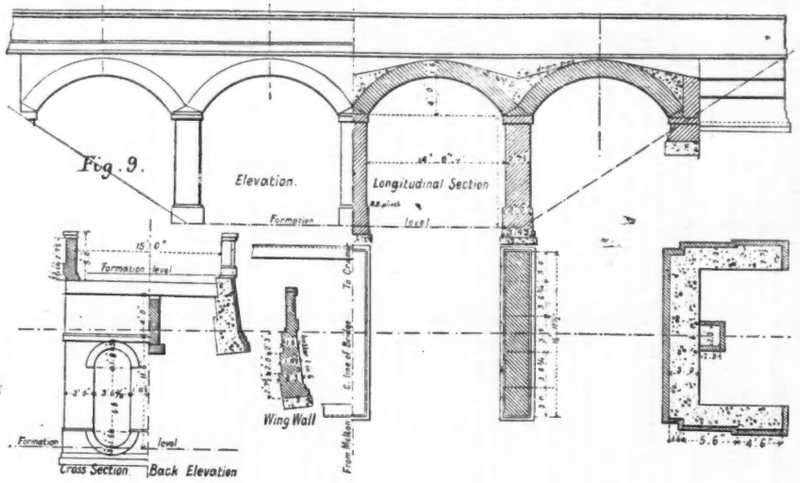


Fig. 10.

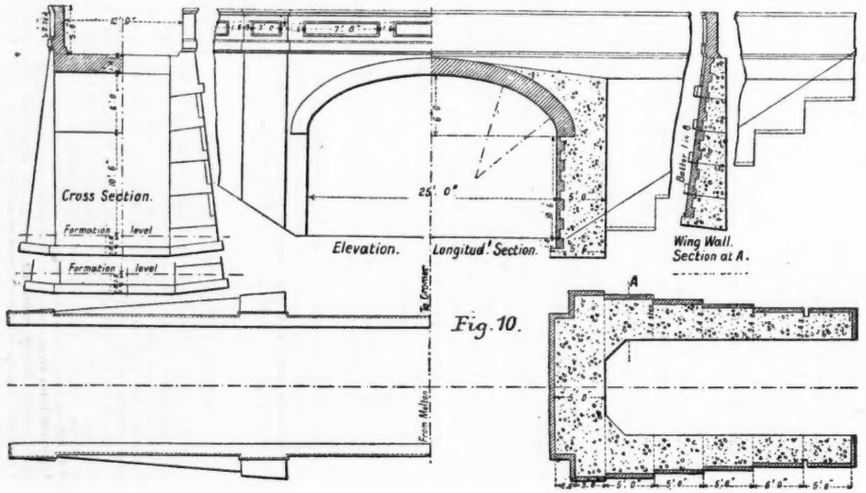
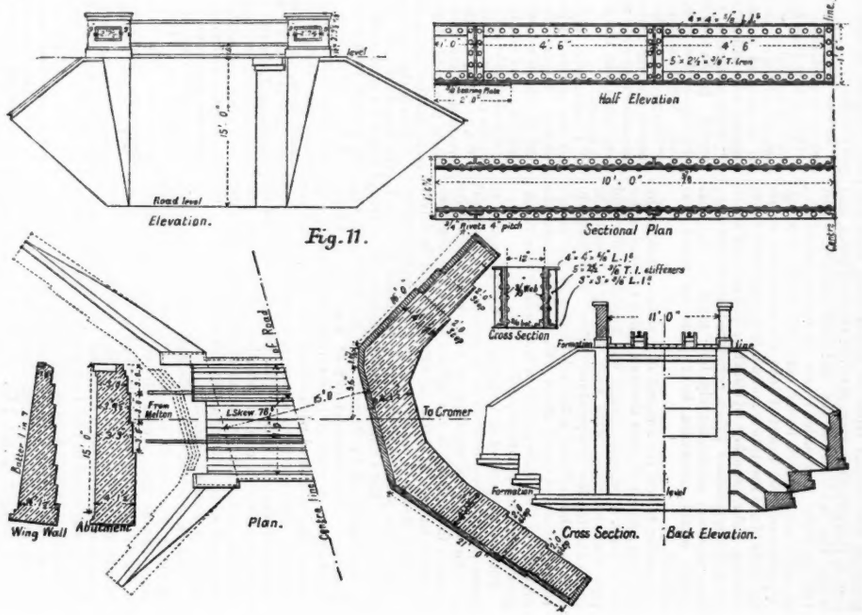


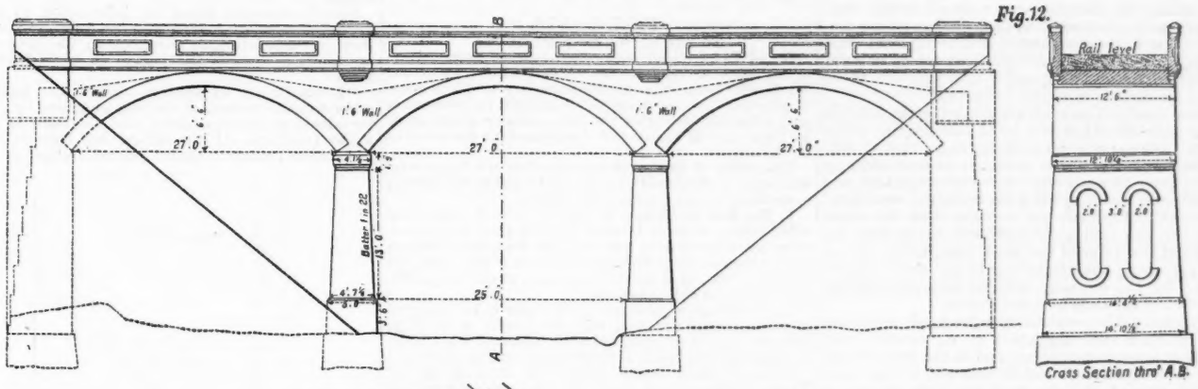
Fig. 11.



BRIDGES AND STATION YARDS; EASTERN AND MIDLANDS RAILWAY.

MR. WILLIAM MARRIOTT, ENGINEER.

Fig. 12.



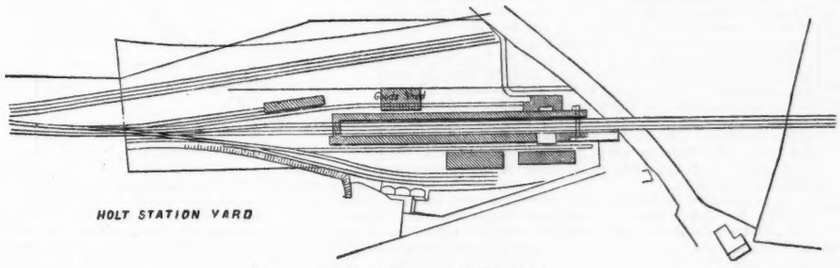
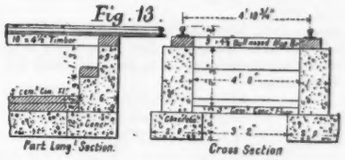
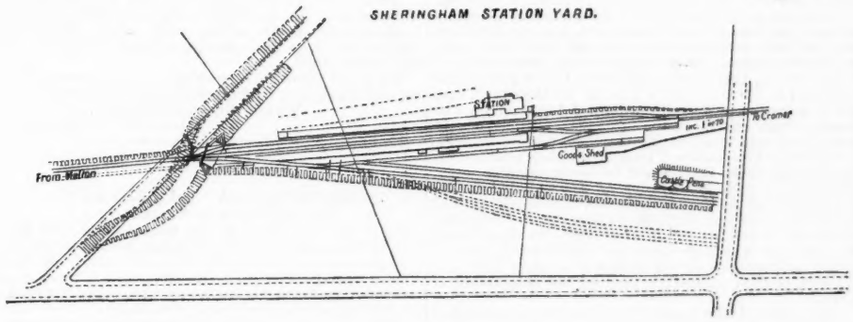


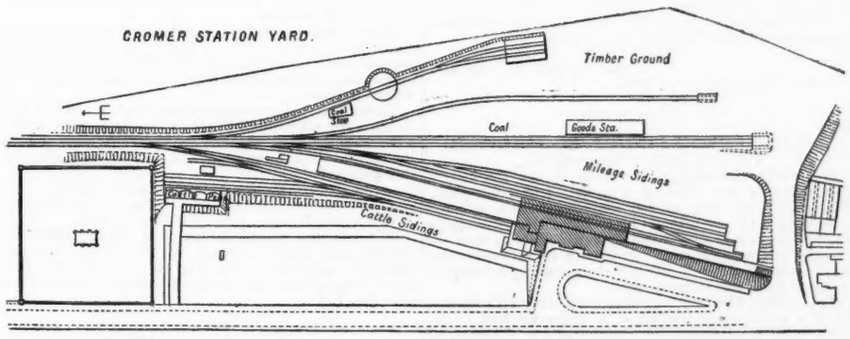
Fig. 13.



SHERINGHAM STATION YARD.



CROMER STATION YARD.



THE EASTERN AND MIDLANDS RAILWAY EXTENSION TO CROMER.

(*Continued from page* 31.)

A RATHER more elaborate form of bridge is shown in the four-arched example in Fig. 9. This is suitable for a narrow roadway where headway is of importance, although it is rather more expensive than the elliptical arch. In the under bridges of small span to economise headway and so save excavation, the rails are carried on balks in trough girders as in Fig. 11. From rail level to the soffit of the troughs is but 12 in. Fig. 12 represents a neat and inexpensive three-arch under-bridge. This has been built in red brick with arches in white relieved by blue brick in piers and imposts which produces a very pleasing effect.

The fencing consists of eight wires, two of which are the galvanised barb which forms a most effectual protection against stock.

The rails used are of the Vignoles pattern and are fastened to the sleepers by means of clips and fangs, no holes being bored in the flanges.

The line will be worked on the tablet system, which is the greatest boon to single-line working. It provides absolute security with a certain amount of elasticity in the train working, so that if one train is late, other trains that it has to cross at various stations can be brought forward. This with the old train staff was impossible, as it takes too long to shift a staff by trolley or by road.

The works have now so far progressed that it is expected that the line will be open for passenger traffic in the spring; they will thus have been in hand for little over twelve months. Nearly 1000 yards a day have at times been excavated in the cutting at Cromer, and this is now nearly finished, the bridges and station buildings are also practically finished, and eight miles of permanent way laid.

The stations at Holt and Sherringham were built by Messrs. Bardell Brothers, King's Lynn, that at Cromer by Messrs. Leach and Sons, King's Lynn, the bridges by Mr. William Wilson, of North Walsham, and the ironwork was supplied by Messrs. Barnard, Bishop, and Barnards, of Norwich. The labour also in the cuttings was sublet.

The following are the general conditions attached to the specifications:

Nature of Contract.—This contract comprehends the supply, delivery, erection, and fixing of all materials, labour, plant, tools, scaffolding, and other matters required for the construction, entire completion, and maintenance for three months after completion of the bridges and platform walls on the Cromer Extension of the Eastern and Midlands Railway.

Supervision.—The works are to be carried out under the construction and to the entire satisfaction of Mr. William Marriott, the engineer to the Eastern and Midlands Railway, or to that of the engineer to the Eastern and Midlands Railway for the time being (hereinafter called "the engineer").

Contractor's Responsibility.—From the commencement to their actual completion the entire responsibility and charge of the works shall rest with the contractor, who, at his own cost, shall make good and restore any portions of the works which may fail; and shall take the entire risk of all accidents and claims caused by the negligence of himself, his agents, or workpeople; and in the event of his neglect or refusal to pay such claims, they shall be recoverable against him as ascertained and liquidated damages.

Neglect or Delay.—The engineer shall have power to require the contractor to remove any person employed by him without assigning any reason for so doing, and should it appear to the engineer that the works are not being carried out in a proper manner or with sufficient diligence he shall have power, after having given forty-eight hours' notice in writing to that effect, to take possession of the works, and all materials and plant on the ground and to discharge the contractor from the works without allowing him any compensation.

Materials and Workmanship.—The whole of the work shall be constructed of the best materials of their respective kinds; and the engineer shall have power to require the immediate removal of any work or materials that may, in his opinion, be inferior, and should the contractor fail to do so the engineer shall have power to himself remove, or cause to be removed, such inferior work or material, and charge the contractor with the cost of so doing, which charge shall be deducted from any moneys due to him.

Alterations, Diminutions, and Additions.—The work is to be done in accordance with the drawings, quantities, and specification attached, but should it become necessary in the opinion of the engineer at any time to increase, diminish, or alter the form or dimensions of any part of the work, the contractor shall comply with any order he may receive from him to that effect in writing. The additions, diminutions, or alterations will be allowed for or deducted at the rates given in

the schedule of prices and the general contract shall not be vitiated thereby.

Dimensions.—Should any discrepancy or ambiguity exist between the scale attached to the drawings and written dimensions, or between the drawings and specification, the same is to be referred to the engineer, whose decision shall be final, and anything contained either in the specification or drawing alone shall be as binding on the contractor as if contained in both. The written dimensions upon the drawings are to be taken in preference to scaled dimensions.

Making Good.—The contractor must make good all damage or detriment caused by or through the works whether to the company's property or to that of surrounding owners (public or private); he must clear up and cart away all waste and rubbish on completion, and leave all neat, clean, and in a workmanlike condition.

Payment.—Payment on account will be made monthly on the engineer's certificate based upon his estimate of the value of the work done, to the extent of 90 per cent., the remaining 10 per cent. will be retained by the company without interest until the completion of the term of maintenance.

Completion.—The contractor must hand over the works (finished and completed) in six months from the date of order to commence, and in the event of his failing to do so he shall forfeit and pay to the company the sum of 50*l.* per week for each and every week that the works shall remain incomplete, which sums the company may recover as ascertained and liquidated damages.

The works have been carried out under the personal supervision of Mr. Marriott, the company's engineer and locomotive superintendent, ably assisted by Mr. R. M. Parkinson.

(*To be continued.*)

HYDRAULIC INGOT CRANE.

THE 5-ton hydraulic ingot crane, which we illustrate on page 60, has been constructed by Messrs. Tannett, Walker, and Co., of Leeds, for the Hallside Steel Works. There are three lifting rams, the centre being of larger diameter than the two outer ones. The former acts as the crane post, and also is constantly subject to a pressure nearly sufficient to balance the deadweight of the crane. Structural considerations require that the cross-section of this ram shall be much greater than the area subject to the hydraulic pressure, and consequently the water is confined to an annulus between the upper and lower portions of the ram. The lifting of the load is effected by one or both of the two outer cylinders, according to its weight. By this arrangement there is effected a great economy of water. The upper part of the crane is rotated on the post by the cylinders shown on the left tie-rods. These work chains which pass round fixed sheaves on the neck of the post, one part of the chain being paid out, and the other drawn in as circumstances require. The monkey is moved in and out radially by the ram on the right. All the motions of the crane are under the control of one man, who has perfect command of it.

DISSOCIATION IN THE STEEL FURNACE.

TO THE EDITOR OF ENGINEERING.

SIR,—Claude Deville's dissociation hypothesis was based on the assumed invariability of the specific heats of the gases. But after Berthelot and Vieilles' recent refined and exhaustive experiments, by which they have incontestably demonstrated that the specific heats of gases increase with their temperature, it is hardly admissible to assume that dissociation is the true explanation of the inadequate transformation of a theoretical thermic value into radiant or dynamic energy, and I fail to see that dissociation plays any part in the action of a steel furnace. Once the walls of a furnace have attained a temperature ample to maintain the incandescent condition of the carbon atoms constituting the luminous portion of the combustion, the air supply can be so reduced that an attenuated and luminous flame of an extraordinary length can be obtained, and the incandescent and unoxidised carbon particles remain intact in the other inert (because oxidised) gases, until the carbon meets with its exact equivalent supply of oxygen for its oxidation to CO_2.

In a cold furnace, the greater density of the comburant and oxidisable gases, the greater temperature difference between the flame and the furnace sides, and the far greater volume of air required to effect the oxidation of the comburant gases produces a short and more solid luminous flame, and were the air supply reduced to the exact equivalent proportion, the combustion would be incomplete and of a smoky nature; whereas, so soon as the temperature of the furnace attains the degree equivalent to that required to effect the oxidation of the carbon, the air supply can be gradually shut off, to almost the exact equivalent proportion.

I believe the wearing away of the gas ports of the recuperative gas furnace, which we owe to the inventive genius of Mr. Frederick Siemens, is principally due to the action of erosion by the impact of the atoms of carbon against the sides of the ports, as the carbon atoms leave the zone of the oxidation of the hydrogen, or by attrition as they pass through the opposite ports into the recuperator chambers.

Yours faithfully,
B. H. THWAITE.

37, Victoria-street, Liverpool, January 16, 1887.

P.S.—Is not the shortening of the flame in recuperative burners simply due to the increased supply of heated air to the flame consequent on the increased temperature of the chimney? This, my experience appears to teach me, is the correct explanation.

FIRE BOATS.

TO THE EDITOR OF ENGINEERING.

SIR,—We have read with much interest in your issue of the 14th inst. the paper on "Fire Boats," read by Mr. W. Cowles before the American Society of Mechanical Engineers. As our name is mentioned in connection with a floating fire engine we have recently constructed, we hope you will be able to find us space for a few remarks on the subject.

The writer of the paper says he does not know why such small boats should be considered suitable for London—we think we can elucidate this point:

1. The boat at Chicago is used on a fresh water lake without tide, while in London the tide runs out a considerable distance from the shore, so that to be of much service the boat must draw but very little water, a draught of nearly 9 ft., as in the Chicago boat, would frequently prevent its use at London fires.

2. At Chicago we presume the distance to be traversed is not very great; in fact, only the length of the city, while in London property has to be protected from Hammersmith to Woolwich, a distance of over fifteen miles.

3. Great speed cannot always be attained on the Thames, owing to fogs, traffic, tide, &c., so that a number of small boats stationed at various points along the river are more quickly available in case of fire.

Thus it appears to us, for a city like London, on a crowded river, small boats having a shallow draught are more suitable. With regard to the small boats not affording accommodation for many men, all difficulty from this cause can be obviated by providing floating stations to house the boats* (W. H. Maw's patent), with living room for men. By forming these stations on pontoons, the boats may be at any time lifted clear of the water for cleaning or repairs.

As to diameter of streams, the writer is correct in saying few fire chiefs have experience of larger ones than 2 in., and we think we may safely say they do not want to. A 2 in. nozzle is as large as two men can manipulate, and as powerful as it is safe to direct against a building. Even in our most disastrous fires we manage generally to leave the outside walls standing; a 4 in. jet, if it were supplied with sufficient pressure, would, we imagine, demolish even these. Another point strikes us as worthy of consideration, that is, the diameter of hose it would be necessary to use to supply a 4 in. jet at the end of, say, 500 ft.; one line of 8 in. or four lines of 4 in. would not be large enough, and we may safely say that before hose of such dimensions could be got ashore and coupled up, 2 in. jets through two combined lines of ordinary hose or 1 in. jets through single lines would be doing effective work. We have no wish to disparage in any way the Chicago boat, which must be a very powerful auxiliary in case of fire. We must also compliment the author of the paper on the care taken in compiling the table. We simply wish to point out why such boats are not in use here, as it would manifestly be only a matter of a larger hull, and duplicating the machinery to produce the same results if required.

The author of the paper is in error in supposing that the boat for Alexandria is the first fire boat built on this side of the water, as we have made several for various ports at home and abroad. And fire floats have been in use on the Thames since before the days of steam, when the pumps were worked by fifty or sixty men.

Yours truly,
MERRYWEATHER AND SONS.

Greenwich, January 19, 1887.

* See vol. xv., page 24, for description.

JOINTS FOR CYLINDRICAL BOILERS.

TO THE EDITOR OF ENGINEERING.

SIR,—We notice that in your issue of the 7th inst. a correspondent puts forward a proposed diagonal joint. This is not a new idea, as the same occurred to us some time ago, and we believe it to have the advantages claimed for it, and our object in writing this is that we thought our experience in proposing to introduce the joint might be of use to any one else intending to adopt it if inserted in your valuable paper.

In January, 1886, we submitted to Board of Trade and Lloyd's surveyors a drawing of a boiler we had to fit, along with triple-expansion engines to s.s. Thames, of London, with this joint, as in the above sketch; we claimed 90 per cent. of the solid plate as its value:

Plate 1 in. thick:

$26.5 \times .9$ in $= 23.85$ required for 90 per cent. 37.75—(ten rivets $1\frac{3}{8}$ in. diameter)$=24$ in. solid plate between rivet holes, being .15 in. in excess of what is required for 90 per cent.

Rivets:

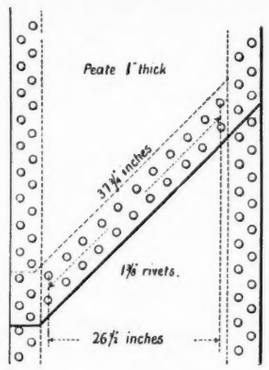
$$\frac{23.85 \times (28 \text{ tons})}{23 \text{ tons}} = 29 \text{ square inches},$$

required rivet area for 90 per cent., twenty rivets at $1\frac{3}{8}$ in. diameter $= 1.4849 \times 20 = 29.698$ square inches, being .698 in. in excess of what is required for 90 per cent.

We did not go beyond this, as we usually stay our fireboxes from the shell, and this is about the maximum that can be got in the shell plates when taken through the stays. The Board of Trade required, before passing a diagonal joint, that we should make an experimental boiler, not less than 4 ft. diameter, having hemispherical ends without stays, and having not less than three rings of plates in the length. The boiler was to be tested to destruction, and the value of same to be used where diagonal joint was adopted. (The boiler we proposed having flat ends, and being stayed, we do not think this test would apply.)

Lloyd's surveyors asked for information as to our method of calculating strength of the joint, and we sent them our calculation, as given below; they then replied as follows as regards the joint; we quote from their letter:

"I am further to state as regards the method of estimating the strength of the joint submitted by you and considered to be self-evident, that the same is viewed to be fallacious. If the design had been so slightly modified as to include twelve pitches instead of eleven



pitches of rivets, your calculations would have shown a result that the joint was equal in strength to the unpierced plate, while if thirteen pitches were taken it would appear to be actually stronger than the solid plate. It is evident at once that these results are not correct."

We had only a limited time to make this boiler, and therefore could not enter into a discussion with these two bodies as to the merits of the joint, so we adopted the double butt shape, and consequently had to increase the thickness of shell.

We do not think the above requires any comment from us, and apologising for trespassing on your space,

We are, Sir, yours faithfully,
DAVID ROLLO AND SONS.

10, Fulton-street, Liverpool, January 12, 1887.

SECONDARY BATTERIES.

TO THE EDITOR OF ENGINEERING.

SIR,—We are desired by our clients the Union Electrical Power and Light Company, Limited, to inform you that it has come to their knowledge that the Electrical Power Storage Company, Limited, and Mr. John S. Sellon acting for them, are intending to injure our clients by writing to the press letters containing libellous statements with reference to the patent and batteries belonging to our clients, both on the merits of the batteries and also on the question of the legal position of our clients as regards their patents.

The statements are of no importance when made by mere trade rivals, but you will see that they will immediately assume great importance if once they receive publicity in the press, and will probably involve all parties in very serious liability.

Under these circumstances, we think it only right to direct your attention beforehand to the matter, and we have no doubt that you will see that any such libellous statements as are contemplated do not find admission into your columns.

We are, your obedient servants,
LINKLATER AND CO.

7, Walbrook, London, E.C., January 17, 1887.

[We are not so well informed as Messrs. Linklater's clients, and know nothing of Mr. Sellon's alleged libellous intentions. We give space to Messrs. Linklater's letter, which, however, calls for no comment from us.—ED. E.]

TORPEDO BOATS.

TO THE EDITOR OF ENGINEERING.

SIR,—I noticed in your last paper on "Torpedoes," mention is made of the strain put upon the crews of torpedo boats when at sea; this is an indisputable fact and can be borne out by many who have only had three or four hours "on the mile." My object more particularly is to draw attention to the development of fast craft and the useless provision that is being made to protect their vitals. The majority of our torpedo boats are entirely unprotected abreast of their engine-rooms. The latest productions (including despatch vessels) are fitted with coal bunkers extending all round the engines and boilers. This sounds very good and looks very well in place, but we have to remember that directly they begin to work their bunkers, the coal naturally gravitates and exposes the parts which require most protection.

When our men get into action and know they have only $\frac{1}{4}$ in. plate between them and Hotchkiss or Nordenfelt bullets, it seems to me they will be unnerved more seriously than if they could actually see their enemy. I for one would prefer being on deck. Again, the targets are gradually increasing in size, the number of boilers are

being multiplied and necessarily the number of crew, with an increased risk of breakdown; this is not mentioning the auxiliaries our authorities seem determined to cram into the engine-rooms. When will they stop to think?

In the current number of *Harper's Magazine*, Sir E. J. Reed, referring to boats of the Grasshopper and Bombe type, says, "There is much uncertainty as to the speed which they will attain." This may well apply to the foreigner, but surely not so in the case of English builders. Many "try to build torpedo boats" it is true, but the south country engineers have been eminently successful with their work; I cannot imagine a firm like Messrs. Yarrow or Thornycroft turning out a boat below the guaranteed speed, and why should they not build the larger type, and at the same time give us the benefit of their experience in steel plating? My opinion is that when once our torpedo boats get within range of the enemy's machine guns (the Whitehead torpedo is no good without), we must "go ahead" and never stop until our torpedoes are sent on their errands of mercy!

Trained men are invaluable, and if only in the cause of humanity, this subject demands serious attention. Speed we must have, but not at the sacrifice of safety.

I am, yours, &c.,

Sunderland, January 19, 1887. FLY-BY-NIGHT.

TOOTHED GEARING.

TO THE EDITOR OF ENGINEERING.

SIR,—In reference to the discussion on the above subject, I take it that if we require a pair of wheels to "gear" together, and to have a given velocity ratio, and we wish the motion of the wheels to be identical with that of two imaginary smooth cylindrical rollers, having no sliding friction, we must so arrange the diameters of the pitch circles that

$$\frac{D}{d} = R$$

where D and d are the respective diameters, and R=the velocity ratio.

Again, we must of necessity make the fraction

$$\frac{N}{n} = R$$

where N and n are the respective numbers of teeth, so that the equation

$$\frac{D}{d} = \frac{N}{n}$$

holds good—that is, the diameters of pitch circles are in direct proportion to the number of teeth, or what is the same thing, the *circumferences* of the pitch circles should be in direct proportion to the number of teeth. As this would only be true when the pitch is measured round the arc, we can only arrive at the one conclusion, viz., that the system of measuring the pitch as a chord is not correct in its principle.

I may mention that in the earlier editions of Molesworth a table was given founded on the chordial pitch system, but I notice in the later editions of his work the said table has been left out and replaced by a set of tables based on the "arc" pitch system. This speaks volumes for the latter method.

Again, in Burgh's "Practical Rules for Steam Engines and Boilers," page 326, the following passage occurs:

"When setting out the teeth of a wheel or pinion it must be remembered that the *circumference* of the pitch line, and the *pitch of the teeth* bear *no* relation to each other, simply because the *pitch* of the teeth is 'diametrical', or a straight line, from a point to a point, while the circumference, or the curved line cannot be accurately (diametrically) measured.

"Some authorities (?) presume that as the diameter is to the circumference so is the pitch to the circumference; for example, a formula is often seen stated thus:

$$\text{Number of teeth} = \frac{\text{Diameter of pitch circle} \times 3.1416}{\text{pitch of teeth}}.$$

"Now this deduction is *false*, because the relation between the polygon and the circle is not constant, which will be clearly seen by referring to Fig. 16, where C is the pitch circle, P the chordial or diametrical pitches, and R the radius.

"The following Table by Professor Willis will be found accurate:

Pitch in Inches.	Factor.
3½	.5570
3	.4774
2½	.3979
2¼	.3581
2	.3183
1⅞	.2785
1¾	.2387
1¼	.1989
1	.1591
⅞	.1193
⅝	.0994
½	.0795
⅜	.0597
¼	.0398

"*Rule.*—Multiply the number of teeth required by the given factor corresponding with the pitch agreed on = radius of pitch circle; then radius × 2 = diameter."

The above is a correct copy of the said article on toothed wheels.

Now mark the chief point of interest. The author first makes out that the formula

$$\frac{\text{Diameter} \times 3.1416}{\text{pitch}} = \text{number of teeth}$$

is *false*, and then he immediately afterwards inserts a table which is based on the very same formula, for the constants are found, as will be easily seen, by dividing the pitch by 2×3.1416, that is

$$\text{Factor} = \frac{\text{pitch}}{2 \times 3.1416}$$

and by the rule given for the same we see that the diameter is in direct proportion to the number of teeth. This agrees with what I said at the commencement of my letter.

Now when "authors differ" so widely, or, as the above author so tersely put it, "some authorities (?) presume," how is a student, for instance, to know which is the correct way of dealing with the question, unless such a journal as your own allows the point to be discussed?

I have found a great deal of difficulty in convincing some of my students (after they have had to do with the chordial pitch system) that they were wrong, and I trust that the discussion at present going on in your paper will be beneficial to more than

Your humble servant,

OMICRON.

Hull, January 15, 1887.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "Toothed Gear" takes exception to terms of my letter in your issue of January 7 inst. Why I do not know; unless for the reason that I asserted "that Templeton, Molesworth, and all other authorities base their calculated tables for pitches and of toothed gear on the rules I had quoted." This I adhere to, and although the rules are axiomatical I will nevertheless prove my assertion to be correct.

Now I cannot see the "spots" in Molesworth where "Discipulus" picked out the multiplier he used for finding the diameters of the pinion of 8 teeth, 3 in. pitch, and the wheel of 120 teeth, 3 in. pitch. For in pages 400-401 of "Molesworth's Pocket Book of Engineering Formula" I find it thus printed: .... "$Z = \frac{N}{\pi}$. Where N = number of teeth and π (Pi)=3.14159. Pitch and diameter of teeth of wheels, values of Z *when pitch is measured round the pitch line.*" The italics are mine. On the top of table under the head of figure 8 will be seen the number 2.5465=value of Z, and $2.5465 \times 3 = 7.6395$ = diameter of pitch line of pinion (Molesworth!) and $\frac{8 \times 3}{3.1416}$ =7.6394 = same as above.

The table does not extend beyond 99 teeth, but let us take this case for analysis. We have 31.5227 = value of Z, and $31.5227 \times 3 = 94.5381$ = diameter of pitch line (Molesworth), and $\frac{99 \times 3}{3.1416} = 94.538$ nearly!

Again, take the case of the wheel of 120 teeth, 3 in. pitch; .31831 × 120 = 38.19720 = value of Z, and 38.19720 × 3 in. = 114.5916 = diameter of pitch line (Molesworth), and $\frac{120 \times 3}{3.1416} = 114.5913$ = above.

I think, Sir, I have proved that both Templeton and Molesworth agree, and base their calculations on the rules I had quoted, and that both "Discipulus" and "Toothed Gear" argue on false premises.

Is it not a deplorable shame that such *sterling* authorities as dear old departed Templeton—whose works made *engineers* of all the intelligent *workmen* of the English-speaking world! Molesworth, Rankine, Unwin, and other's works—should be misconstrued by your careless correspondents.

Sir, in no schoolboy's geography have I seen it stated that Christmas Day in New Zealand is unattended by either *frost or snow*, and attended by *summer heat*; the boy must use his reasoning powers and discover the reason why such phenomena obtain there. So it is with the confounding of the arc and chord pitches in toothed wheels.

I have never seen in any work I had access to, where the calculated pitch is properly defined so as that workmen could discriminate easily.

I have often in my time heard pattern-makers complain and say that Templeton's tables for pitches and diameter of pitch lines *were wrong*, because forsooth they found when stepping round the described calculated pitch circle that the given pitch opening of "dividers" was *always too great*; more especially when the wheels were coarse, *i.e.*, with few teeth—they made the mistake in confounding the *arc* for the *chord* pitch—they did not understand Templeton!

"Toothed Gear" expresses *surprise* that in a pinion of 10 teeth only one tooth should be in gear at the time. Why this is one of the major inherent defects in a pinion of such low number of teeth. The velocity ratio of 13 was too great for a steam crane, it might do well enough for a hand one.

It was bad engineering, and no wonder the pinion was continually breaking. May I ask if it was shrouded, *i.e.*, with flanges cast on sides? Each tooth of pinion was engaged thirteen times for each one tooth of the wheel, thus exposed to thirteen times the friction, and wear and tear, and consequent reduction of strength. The defect, he states, was cured by getting a new pinion with the chord pitch of equal length to that of the wheel and moving back pedestals, &c. Now I am of opinion the cure consisted in the *extra thickness* afforded to tooth by reason of increased pitch and the *possible trimming* of the teeth of the spurwheel, but at the expense of increased friction and "lash." *Ratio of velocities violated!*

I beg to inform "Discipulus" in reply to his extraordinary paragraph at foot of letter, that I have only to reiterate my former assertion, that the *arc pitch* is in all cases the basis of calculation and not the *chord pitch*. To calculate the values for chord pitches would involve an enormous amount of work, viz.: To find the length of side of equiangular polygons inscribed in undetermined diameters of pitch circles, and *vice versâ*, a second edition of the quadrature of the circle, a problem old as the Pyramids.

But as Messrs. "Toothed Gear" and "Discipulus" are so enamoured of the practice of making the chord pitches of unequal pitch circles equal, let them find diameter of pitch circle as hithertofore explained, describe it. Draw a diameter and produce it, at point of intersection draw a tangent, set dividers to proposed chord pitch, place one leg at point of intersection of tangent and mark off pitch on tangent, bisect pitch. Again, bisect portion next point of intersection of diameter. At the *point of second bisection* place one leg of dividers, and from this point as centre with radius equal to remaining *three-fourths* of the pitch, describe an arc cutting pitch circle, through point found draw another diameter, produce it. Now set dividers to required chord pitch, and apply the points outside the *calculated pitch circle*, until the points coincide with both produced diameters; the points found thus will of *course* be the *chord pitch*, and the circumscribed circle the *pitch circle* required.

As I have in former letter stated, your foot-note to the first letter of "Discipulus" contained all information required in a "nut shell." I beg to apologise for length of this "Much Ado about Nothing."

Yours truly,

Cork, January 17, 1887. R. HARTLAND.

TO THE EDITOR OF ENGINEERING.

SIR,—I am very glad to see that a correspondence on the subject of Arc *v.* Chord Pitch for the teeth of wheels has been opened in your columns, as the present haphazard way of designing (?) toothed gearing is an abominable nuisance to all engineers who have charge of machinery. Some makers send out their tools with wheels on the arc principle, some on the chord principle, and yet others on what seems to be no principle whatever. Then again we have endless different theories as to how the tooth should be formed; and yet in the end it generally depends entirely on the whim of the man who makes the patterns. Take two wheels of the same pitch from different makers, and it is more than likely that before you can get them to run together you will have to put one in the lathe and turn down the points of the teeth, even then it is questionable if they will work smoothly. If a wheel strip, the man in charge has to consider where the remaining wheel came from, not where he can get another wheel with the least loss of time. If the machine came from a great distance and time is an object, it is often a case of ordering a new pair from some firm who can deliver quickly, and throwing what is very likely a perfectly sound wheel into scrap. We have constant complaints from the colonies as to the time wasted in getting repairs done and new parts out from England. The adoption of a regular system of toothed gearing would enable a breakdown to be quickly repaired by borrowing a wheel from some machine which is not so urgently required, but any attempt to do this at the present time is pretty sure to lead to disappointment. I myself have seen a difference of as much as 50 per cent. in the depth of teeth having the same pitch.

Your correspondent "Toothed Gearing" questions whether arc pitch is not wrong because with the tooth set out in a certain way he only gets one tooth doing the work. Would it not be an equally logical deduction to say that because with arc pitch he only gets one tooth in gear, therefore his method of setting out the tooth is wrong? There is a good deal to be said in favour of arc pitch, but I am not aware that very much can be said in favour of setting out the tooth with a radius equal to the pitch. By this method you may get a tooth, which is a thing of beauty, but as to its being a joy for ever—well, that is a different matter.

Sir J. Whitworth earned the gratitude of engineers nearly the whole world over by the action he took in reference to the pitch and form of screws. Can no influential engineer be found who will take similar action in the matter of teeth of wheels? Here is a find field for some of our engineering associations. I venture to hope, Sir, that if correspondence on this subject lags, you yourself will keep the subject warm.

"Discipulus" will find the tables he requires, also a most lucid and interesting chapter on Arc *v.* Chord Pitch in "Binn's Orthographic Projection," Part II., published by E. and F. N. Spon.

January 19, 1887. MILLWRIGHT.

HUDSON BAY RAILWAY.—Dr. Robert Bell, of the Canadian Geological Survey, has returned to Ottawa from a four months' exploration of the Severn district, south of Hudson's Bay. The result of his observations is to show the practicability, so far as the construction is concerned, of the proposed Hudson Bay Railway. The character of the country, Dr. Bell says, is in every respect adapted to the construction of the line, and no engineering difficulties of any importance will be met with. Churchill Harbour is open five months in the year, and the Straits will meet all requirements. Mr. W. Ford Buchanan, who is interested in the Hudson Bay Railway, states that forty miles of the line are about to be built, and that money will be forthcoming to complete it. Mr. Buchanan says the people in the North-West are interested in this short route to Europe, because of its facilities for a short haul of grain and its advantages for cattle shipments. The Canadian Government, he says, has bonused the line by land grants, and Manitoba has guaranteed its bonds for that portion running through its territory. It is also affirmed that English capitalists will put on a line of steamers to run through Hudson Bay and the Straits to Liverpool.

FIVE-TON HYDRAULIC INGOT CRANE AT THE HALLSIDE STEEL WORKS, GLASGOW.

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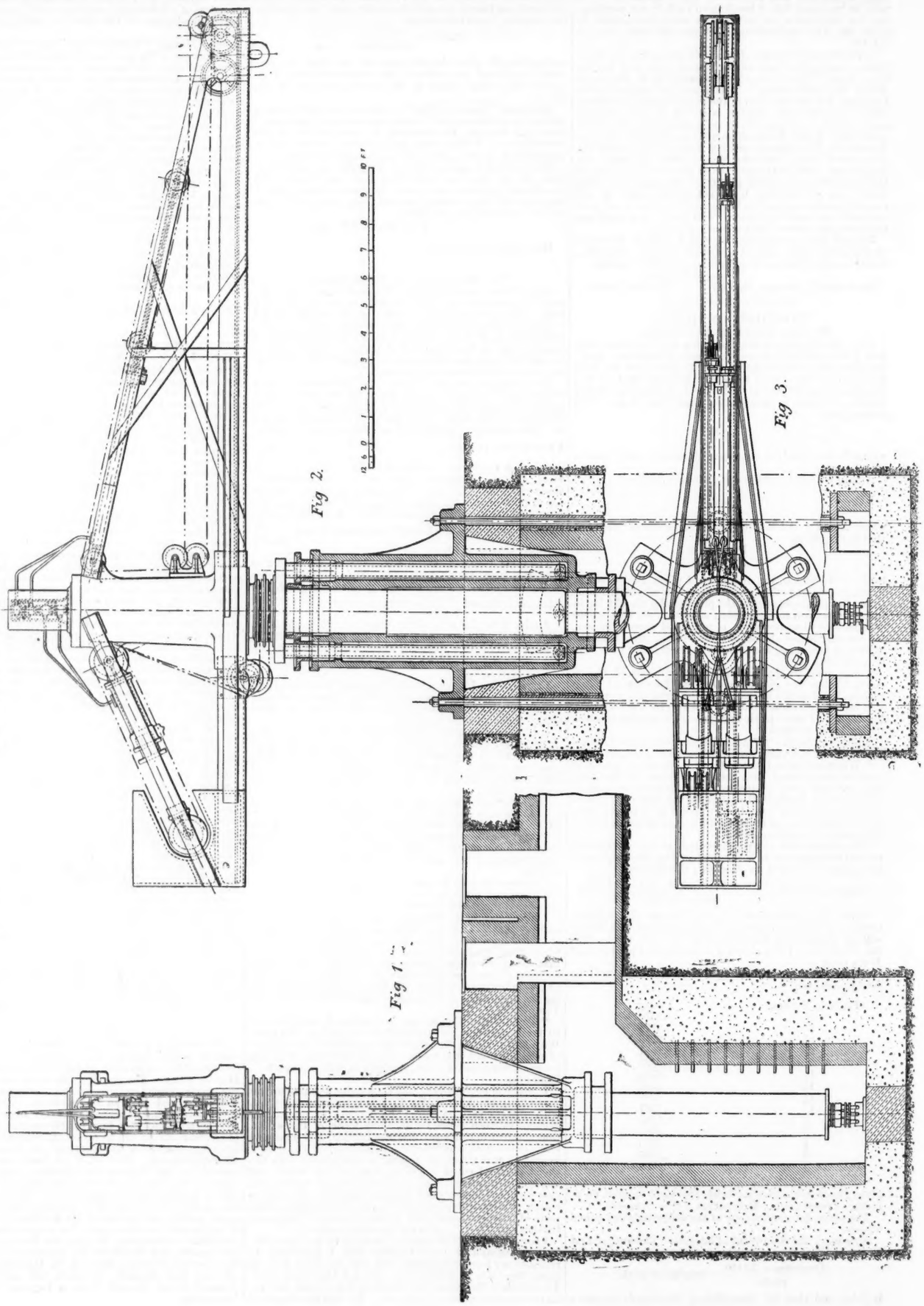
(*For Description, see Page 58.*)



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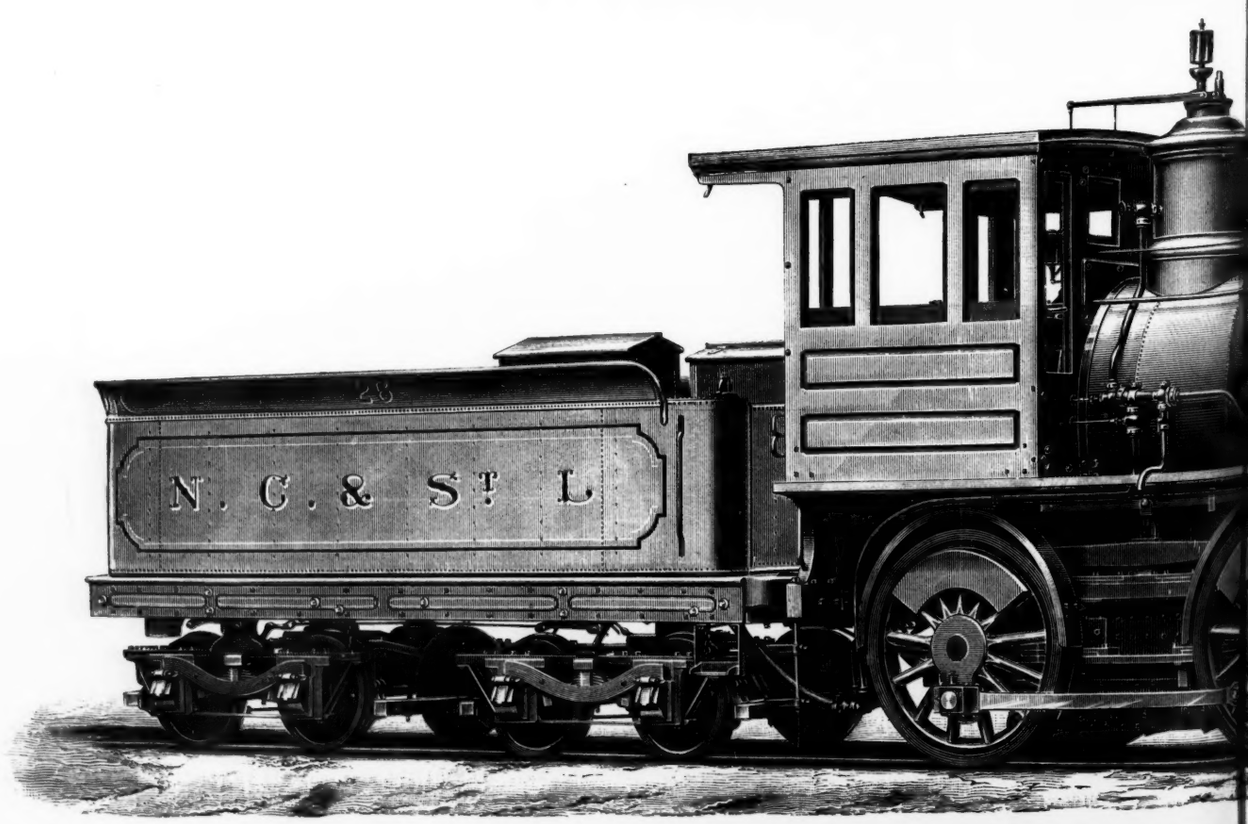

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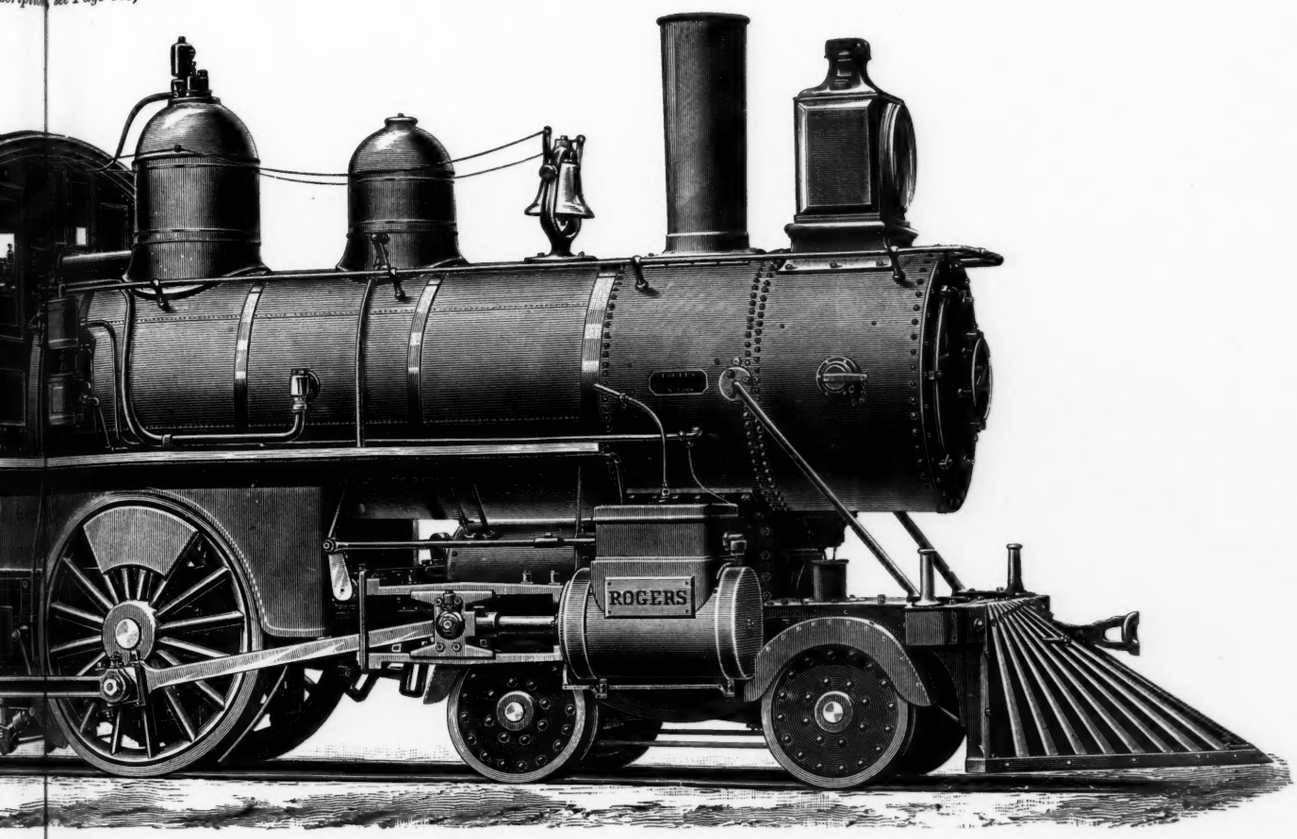

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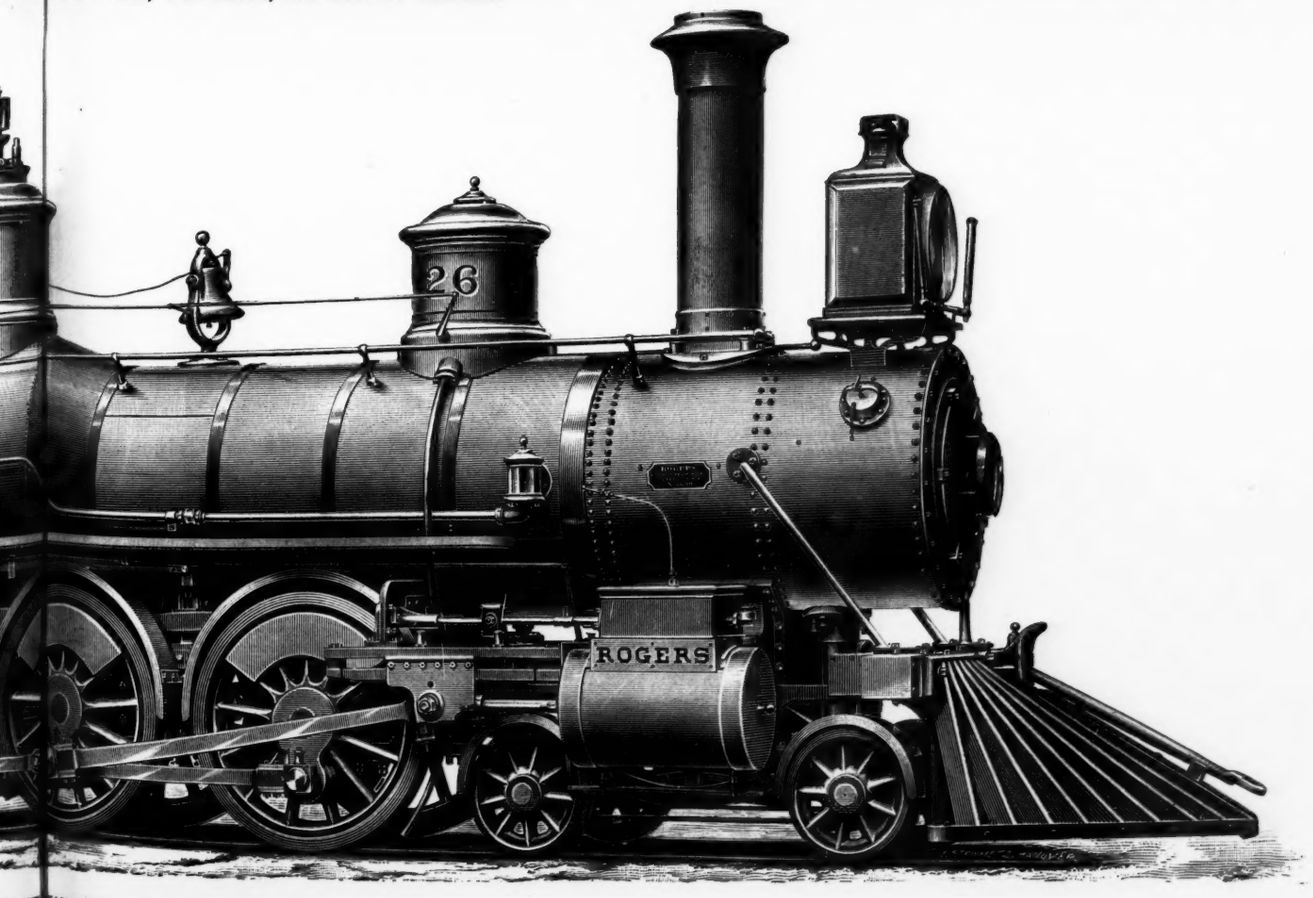

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NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Students' meeting, Friday, January 21st, at 7.30 p.m. Paper to be read: "The Use of Cast Steel in Locomotive Construction," by Alfred J. Hill, Stud. Inst. C.E. — Ordinary meeting, Tuesday, January 25th, at 8 p.m. Papers to be read with a view to discussion: 1. "Sewage Sludge and its Disposal," by William Joseph Dibdin, F.C.S., F.I.C. 2. "Filter Presses for the Treatment of Sewage Sludge," by William Santo Crimp, Assoc. M. Inst. C.E., F.G.S.

THE SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Meeting at the Institution of Civil Engineers, 25, Great George-street, S.W., Thursday, January 27th, at 8 p.m. "Telephonic Investigations," by Professor Silvanus P. Thompson, B.A. D.Sc., Member.

SOCIETY OF ARCHITECTS.—The fifth ordinary meeting of the Society of Architects for the session 1886-7 will be held in the Freemasons' Tavern, Great Queen-Street, W.C., on Tuesday, January 25th, at 7 p.m., when a paper will be read by Mr. Basil Champneys, B.A., Camb., entitled "Architectural Styles, Old and New."

ENGINEERING.

FRIDAY, JANUARY 21, 1887.

NAVAL ADMINISTRATION.

THE coming Naval Estimates will have an additional interest, and the probable lines they will be framed on are already beginning to be conjectured by those who are, or who profess to be, in a position to make a forecast. The hostilities between the spending departments and the Treasury, which are always smouldering, and have up to the present been held in check by the overwhelming superiority of the element of finance, have at length culminated in a general engagement, and finance has for the present been driven off the field; whether defeated or not perhaps remains to be seen.

A peculiarity of the present conflict is that hostilities have been carried on to a great extent *coram populo*. As the fabled heroes of old invoked the aid of their gods when hard pressed, so the Admiralty, finding itself outmatched by the overwhelming power of the Treasury, has appealed to the divine *vox populi* through the medium of the public press. The first cry was heard in the columns of a contemporary several weeks ago. It is true that in this case but little was said about more money being required, but to carry out the suggestions then made must have meant additional expenditure or else a far more economical and efficient management than it will be possible to attain except by a long process of salutary reform. The energetic and business-like financial Secretary to the Admiralty has also made his voice heard through the medium of the press, for, although Mr. Forwood in form addressed his speeches to a few people at the meetings of Liverpool and Ormskirk, they were in effect spoken more to the newspaper reporters to be by them conveyed to the whole empire. With Lord Charles Beresford's circular (the substance of which we by no means wish to insinuate he communicated to the *Pall Mall Gazette*, for such an act would be foreign to his outspoken and sailor-like character), we think, no one could find fault, except perhaps some hide-bound economist of the Treasury, who, as Lord Carnarvon has said, "would gauge public requirements by the sole measure of arithmetic."

Mr. Forwood's two sounding appeals to the public contain much that should serve to rouse a proper spirit of responsibility in this country with regard to the Royal Navy. He is, as he stated at Ormskirk, the first managing owner of steamships that has been so closely connected with naval affairs, and he appears to be bringing that business common sense that must distinguish every successful manager of mercantile ships, to bear on the naval question. We will not dwell on his oratorical efforts; such as "it is the paramount duty of every British statesman to see to the protection of his country and its trade," &c. Things of this kind are always said, but the novelty in Mr. Forwood's case is that he appears, not only to mean what he says, but intends to act up to it.

Mr. Forwood's second speech was made after Lord Randolph Churchill's resignation, which latter has been the most striking example we have had of an appeal to the higher power. Lord Randolph's *coup* probably had the effect of shaking his adversaries' nerves, for it drove Mr. Forwood to follow the usual course of giving at Liverpool a forecast of the coming estimates. They will, he said, show a substantial reduction from the estimates placed before Parliament by the last Board.

Lord Charles Beresford, who, although only Junior Naval Lord, is in public estimation perhaps the most prominent member of the Board, has been even more outspoken than Mr. Forwood. He is still crying out for his twenty cruisers; unless the *Times* is justified in announcing that he has already got them.

In the mean time the finance people were not going to let the expenditure party have a monopoly of outside support if public approval could be won by the asking for it. The Chancellor of the Exchequer's retirement has of course been the great event to bring the question of Navy and Army expenditure to the fore, but it is necessarily so much a political question that we are at a loss to determine, in spite of all statements made with so much assurance, how far it was prompted by the reasons ostensibly set forth. The publication of the Treasury minute was, however, a palpable appeal for public support, and, we think, bears unmistakable evidence of having been penned for that purpose. In it all the old stock arguments are used. "Advance in the income tax," . . . "Necessity of increased watchfulness over public expenditure," . . . "Economy, necessary at all times, becomes imperative during periods of prolonged pressure," and such catch phrases as can hardly have been penned for the benefit of heads of departments. In any case, whoever addressed to, they are obviously aimed only at the two great spending and unproductive departments of the State. The First Lord of the Treasury and Chancellor of the Exchequer would scarcely ask the Post Office, Revenue, or other income producing departments to reduce the public income by curtailing the means of collecting such income. The whole document, read in the light of common sense, is like a schoolboy's copy-book. If the First Lord of the Treasury and the Chancellor of the Exchequer had copied out some of those dear familiar truisms of our early days, "Be virtuous and you will be happy," "Cease to do evil, learn to do well," they would have produced as sensible a minute. There is not a single practical suggestion in the whole composition. That due economy should be observed in the expenditure of the public moneys, goes without saying. It is as obvious a duty of heads of departments as that they should keep their hands out of their neighbours' pockets. The minute is a political firework, and has proved somewhat damp in going off.

There are other points in the addresses of Mr. Forwood and Lord Charles Beresford of a more substantial character. To judge by what these two members of the Board of Admiralty have said there should be now in progress an effort from within for Admiralty reform. It is unwise to attribute too much importance to the vague promises of old Parliamentary hands, but neither Mr. Forwood nor Lord Charles are old in office and their utterances are fairly explicit. At Liverpool the Parliamentary Secretary of Admiralty said, "I must confess that the present Admiralty mode of performing work is expensive. This is incident to the system of Admiralty administration. A system, however, which has been the creation of centuries cannot be revolutionised in days and weeks. We are compelled to work with the tools we have. We cannot postpone our operations until the system of administration is altered. We have, however, set ourselves to work to improve our establishment, and I hope that before long we shall be able to carry on our operations at reasonable cost and charges."

The Junior Naval Lord goes much further than his colleague, indeed his utterances are so startling as to rouse the fear that, in place of being misled by the blandishments of old Parliamentary hands, our expectations may fall victims to the over-sanguine promises of youthful enthusiasm. If we read Lord Charles's speech aright he would abolish political First Lords altogether, and he spoke as one of the present Board, and apparently has the approval of his colleagues. In his Grantham speech, Lord Charles said: "He was not going to blame their (the Admiralty's) predecessors for what had occurred, but he blamed the system under which they worked. . . . . They would all admit, every Englishman would agree, that the Navy did not exist for party purposes at all; the Navy existed for national purposes. But there was no doubt that under the old system, when Government changed, a despotic power was entirely vested in the First Lord of the Admiralty, who had largely to manage its affairs. He was speaking of First Lords with a party programme. When certain reforms or orders were necessary for the government of the Navy, the despotic power vested in the First Lord allowed him to go entirely against the Board. In fact the old system existed at the present moment. The Admiralty might form a strong opinion on a matter and the whole Board give their opinion unanimously, and yet the First Lord might use the despotic power he possessed and overrule the whole Board." Lord Charles, having said so much against First Lords of the Admiralty in general, had to make an exception in favour of his own chief, who, according to Lord Charles, is an ideal and altogether exceptional First Lord, whose like was never seen before, and, we may therefore reasonably conclude, will seldom be seen again. Later on, Lord Charles said: "He hoped the present system would be done away with, for they were bound to look to the Navy for a great deal. . . . . He had endeavoured, so far as he could, to avoid throwing any blame upon his predecessors, because they

worked under a system, and he did not think they could have done better. But what they wanted to do was to alter that system."

There is no mistaking the tendency of these utterances of two members of the Board of Admiralty. They are both shrewd men enough, and have taken office with intellects unobscured and energies undeadened by a long education in the cumbrous strategy of political tactics and routine. Mr. Forwood has kept his business intelligence intact even in the artificial atmosphere of Whitehall, and Lord Charles Beresford has seen ships and guns, not merely as items of a political programme, but in their legitimate position as instruments of war. So far, these two gentlemen seem to have had the courage of their opinions, and it is to be hoped they will be able to push their principles to a practical and logical conclusion. Nothing could be more refreshing than the contrast between the expressions above quoted and the special pleading in support of the political situation of some past Admiralty representatives in and out of Parliament.

All these considerations give the coming Naval Estimates, and the discussion that will be raised on them, an unusual interest. We already know that, so far from being startling by their excess, they will show a slight reduction. Until the means by which this reduction has been attained are known it would be premature to express satisfaction or regret on this point. To reduce the expenditure by simply cutting down the figures would be easy and mischievous, to obtain the same end by better administration would be most difficult and meritorious. We shall shortly see which course has been followed.

THE ELECTRIC LIGHT AT THE COLONIAL AND INDIAN EXHIBITION.

THE Electric Lighting Committee of the Colonial and Indian Exhibition have issued a most interesting report giving full particulars of the lamps and machinery employed, and the details of the contracts entered into with the various firms who carried out the lighting. As we are threatened with a deluge of exhibitions this year, and as the electric light will be a prominent feature at each, the report will be diligently studied by all who have undertaken the task of attracting the public, and, at the same time, of making a profit out of the enterprise. Unfortunately, as the last Exhibition succeeded to a good deal of plant from its predecessors, it is impossible to arrive at the exact expenditure, but still a very fair idea of the cost of lighting can be obtained.

The installation naturally divides itself into three portions; that devoted to (1) the interior of the buildings, (2) the gardens, and (3) the fountains. The cost of the interior lighting was 14,523*l.* 2s. 2d., exclusive of salaries of staff and office expenses, and of the plant taken over from the preceding Exhibition. Of this Messrs. Davey, Paxman, and Co. received 4683*l.* 5s. for providing about 1000 horse-power to drive the dynamos of the various contractors, and also those in charge of the committee, the payment being at the rate of 1½d. per horse-power per hour. The Anglo-American Brush Electric Light Corporation, Limited, received 2112*l.* 9s. 3d. for providing and working 160 arc lamps for 596¼ hours, and ten lamps for 483 hours, the sum being about at the rate of 5d. per lamp hour. Messrs. R. E. Crompton and Co. received 1679*l.* 18s. 10d. for providing and working 140 arc lamps for 578 hours, this also is about 5d. per lamp hour. The Pilsen-Joel Electric Light Company, Limited, received 1380*l.* 17s. 10d. for 113 lamps in work for 593 hours; 225*l.* were paid to the Edison-Swan Company for the hire of eight dynamos; 80*l.* to Messrs. Elwell-Parker for another machine; and 400*l.* for the hire of two secondary batteries of 424 cells in all. These sums account for 10,561*l.*, the remainder being spent, we presume, on plant and wages.

The gardens were lighted by Messrs. Galloway and Sons, who provided engines, boilers, and dynamos, and also purchased all the plant, which had been taken over by the Commissioners from Messrs. Siemens Brothers at the close of the Inventions Exhibition. The total number of incandescent lamps in use at the commencement of the Exhibition was 9624, but was subsequently reduced to 8584. Of these 8034 were of five candle-power, 414 of ten candle-power, and 136 of twenty candle-power. In addition to the incandescent lamps 18 arc lamps of the Brush type were placed on three iron masts. The total number of hours working was, for the incandescent installation, 376 hours, and for the arc lamps 403½ hours. The entire sum paid for this work was 9970*l.*, less 5460*l.*, the price of the plant transferred to the contractors. A part of the latter consisted of the three 3-cylinder engines which drove the Siemens dynamos so unsatisfactorily last year.

The lighting of the fountains was also carried out by Messrs. Galloway and Sons. Sixteen large arc lamps, requiring in the aggregate 200 ampères and 210 volts, were used during 212 evening displays for a total of 106 hours. The sum paid was 1973*l.* 10s. 1d. The total cost of the lighting was as follows:

	£	s.	d.
Internal lighting...	14,523	2	2
Garden ,, ...	9,970	0	0
Lamps broken by public ...	126	17	6
Fountains...	1,973	10	10
	26,593	10	6

But this, as stated before, does not include salaries and office expenses, nor the value of the plant existing within the buildings when the Committee commenced their labours. If new conductors had had to be laid down another very heavy item would have been added to the cost.

The Committee report that the lighting was very successful, and that there were practically no fines imposed on the contractors, except in the case of Messrs. Crompton and Co., who were mulcted in 150*l.* 1s. 2d. This sum, at the rate of one penny per minute, represents 36,014 lamp-minutes of extinction. The irregularity did not arise so much from the bad behaviour of the lamps as from the failure of the dynamos, twenty-five of which broke down in a short period. The amount of light per square foot of floor surface appears, with a few exceptions, to have been fairly uniform in all parts. It is curious, however, that the South Promenade, which contained the most beautiful and interesting portion of the collection, formed one of the most notable exceptions to the rule. In this department there was one lamp to each 4444 square feet, while in the general area lighted by the Brush Company there was one lamp to 1090 square feet. This firm expended an energy of .44 watt in lighting each square foot of floor in their section. This average differs slightly from those of Messrs. Crompton and Co. and of the Pilsen-Joel Company, which were .52 watt and .32 watt respectively. It would, therefore, seem that in lighting exhibition buildings it requires about one indicated horse-power for each 1000 square feet of floor space if the galleries are spacious, while if they are small a more liberal allowance must be made. This is probably the simplest and most intelligible way in which to express the amount of light required, as candle-power is a somewhat elastic unit in the hands of manufacturers.

The interior incandescence lighting was carried out by the Committee, and involved the average expenditure of 1.4 watts per square foot of floor, the figures varying between 1.3 and 1.83. A record was kept of the life of the lamps, but it is incomplete from two causes; in the first place many lamps were not new to begin with, and in the second the 600 hours of burning were not long enough to fully test the capability of the new lamps. They were, however, quite sufficient to show that many lamps give out long before the limit of 1000 hours is reached. Among the new lamps which burned the full 600 hours we notice several lots which had a mortality from 20 to 30 per cent, and in one case every lamp in a small consignment was destroyed. The officials report that the old 96-volt Edison lamps and the 100-volt Woodhouse and Rawson lamps showed the longest lives.

The report includes a letter from the Phœnix Fire Office, in which the thanks of the office are offered to Mr. J. H. Cundall for the skill and care with which he had carried out the installation. In reply to this letter the Committee pointed out that not a single accident of any kind had happened, and that the lighting had been entirely successful.

THE DEPRESSION OF TRADE.

AT last the labours of the "Royal Commission appointed to inquire into the Depression of Trade and Industry" are complete so far that the final report was published on Tuesday last. This is the fifth instalment of the report, four large volumes of minutes of evidence, appendices, &c., having already appeared. The mass of information collected together is very large, and if no good result follows from the labours of the Commission it can certainly not be for the lack of material on which to base conclusions pointing towards legislation.

The Commission, as might be expected, is by no means unanimous in its report. There were twenty-three commissioners in all, besides the secretary, Mr. G. H. Murray, and an assistant-secretary. There were two final reports, and of the twenty-three commissioners only eight signed the final report of the majority unconditionally. These were the late Earl of Iddesleigh, Mr. John Aird, Sir James Allport, Messrs. T. Birtwistle, David Dale, C. J. Drummond, W. L. Jackson, and William Pearce. Ten members signed the majority report with reservations. These were Messrs. G. Sclater-Booth, Lionel L. Cohen, J. P. Corry, H. H. Gibbs, H. H. Houldsworth, G. A. Jamieson, R. H. I. Palgrave, Charles M. Palmer, Bonamy Price, and Samuel Storey.

In addition to these a minority report was presented by Lord Dunraven, Messrs. Farrar Ecroyd, Nevile Lubbock, and P. A. Muntz; while Mr. Arthur O'Connor had prepared a long report entirely on his own account. He had come to the conclusion that the evidence was too "fragmentary and restricted," although thirty-seven days were devoted to taking it. For the present we propose to do no more than refer to some of the salient features in the report itself, reserving the conclusions and recommendations framed by the Commission for another notice. We also hope to discuss some of the evidence given on subjects more especially of interest to our readers at a future date.

As our readers are aware, the scope of the inquiry extended back only for a period of twenty years, and this period was considered sufficient to afford "a standard by which the estimates of the depression could be more or less exactly measured" without "carrying back the investigation into periods in which the conditions of the trade and industry of the country differed too widely from those which now affect it." The chief inquiries were divided into thirteen sections, and were framed to elucidate the following points:

(*a*) Changes in the relation between capital and labour.
(*b*) Changes in the hours of labour.
(*c*) Changes in the relation between the producer, the distributor, and the consumer.
(*d*) Fall in prices on the appreciation of the standard of value.
(*e*) The rate of the currency and banking laws.
(*f*) Restriction or inflation of credit.
(*g*) Over-production.
(*h*) Foreign competition.
(*k*) Foreign tariffs and bounties.
(*l*) Incidence of taxation, local or imperial.
(*m*) Communication with other markets.
(*n*) Legislation affecting trade.
(*o*) Legislation affecting land.

These questions were directed to the capitalists and employers, but a separate set were drawn out for trades unions and other bodies representing the working classes. These were as follows:

(*a*) The number of persons connected with the several trades, distinguishing the employed from the unemployed.
(*b*) The general character of the trade of the district, whether depressed or otherwise.
(*c*) The hours and conditions of labour and the rate of wages.
(*d*) The growth of production.

The various answers to these questions are duly set forth in an appendix to the report, to which we must refer those of our readers who wish to follow the question in detail, as they are far too voluminous for the limited space we have at our command. "After much deliberation" the Committee came to the conclusion that it would not be desirable "to examine witnesses from every separate branch of industry in the country, a decision for which we must confess some feeling of gratitude, as the "four typical industries of the country" require for their treatment something approaching 2000 folio pages of closely printed matter. These four industries were the iron and coal trades, the textile industries, agriculture, and shipping. In the iron trade the chief witness was Sir I. Lowthian Bell, who is the President of the British Iron Trade Association. In addition to his verbal evidence this gentlemen prepared an elaborate essay or treatise on the subject, which is incorporated in one of the

appendices. In addition to Sir I. Lowthian Bell, Mr. Josiah T. Smith, the managing director of the Barrow Hematite Steel Company, Mr. W. A. Donaldson, of James Watson and Co., of Glasgow and Middlesborough, Mr. John D. Ellis, the chairman of John Brown and Co. and of the South Yorkshire Coal Association, Mr. T. E. Vickers, of Sheffield, and other gentlemen connected with the iron and steel trades were examined.

The witnesses on the textile industries included representatives of the cotton, woollen, linen, jute, silk, and lace trades. The agricultural witnesses were not numerous in comparison with the importance of the question; but Sir James Caird covered almost the whole ground in this section, in addition to which a short time back a very influential commission held an inquiry on agricultural depression. On the shipping and shipbuilding question there were several witnesses, including Mr. R. Knight, the general secretary of the Boilermakers and Iron Shipbuilders' Society, Mr. J. Price, the general manager of Palmer's Shipbuilding Company, Mr. W. R. Price, of London, Mr. John Scott, of Greenock, and many others. The question of distribution occupied a prominent position in the inquiry, six witnesses being examined on the question of railway and canal carriage; whilst a great many witnesses spoke of the bad influence of unequal railway rates for goods. The official witnesses, Mr. R. Griffin, assistant secretary of the Board of Trade, Mr. C. M. Kennedy, head of the Commercial Department of the Foreign Office, Mr. S. Seldon, principal of the Statistical Department of the Board of Customs, Mr. A. West, chairman of the Board of Inland Revenue, and Mr. R. C. Harding, Chief Official Receiver in Bankruptcy.

It will be gathered therefore that there was no lack of material for the Commissioners to consider in framing their conclusions, and the following is a brief summary of the opinions expressed in the majority report:

1. That the trade and industry of the country are in a condition which may fairly be described as depressed.

2. That by this depression is meant a diminution, and in some cases, an absence of profit, with a corresponding diminution of employment for the labouring classes.

3. That neither the volume of trade nor the amount of capital invested therein has materially fallen off, though the latter has in many cases depreciated in value.

4. That the depression above referred to dates from about the year 1875, and that, with the exception of a short period of prosperity enjoyed by certain branches of trade in the years 1880 to 1883, it has proceeded with tolerable uniformity and has affected the trade and industry of the country generally, but more especially those branches which are connected with agriculture.

Amongst other causes that have contributed to bring about this state of affairs are named (1) overproduction; (2) a continuous fall of prices caused by an appreciation of the standard value; (3) the effect of foreign tariffs and bounties, and the restrictive commercial policy of foreign countries in limiting our markets; (4) foreign competition, which we are beginning to feel both in our own and neutral markets; (5) an increase of local taxation and the burdens on industry generally; (6) cheaper rates of carriage enjoyed by our foreign competitors; (7) legislation affecting the employment of labour in industrial undertakings; (8) superior technical education of the workmen in foreign countries.

The Commission found that practical unanimity existed as to the depression in the iron trade. It was pointed out that the production of pig iron in this country has, with some slight variations, steadily increased, so that in 1884 the make was 31 per cent. greater than in 1870. During the same period, however, the quantity produced by other nations increased nearly 138 per cent. Sir Lowthian Bell considered these facts due to the increased demand for iron on the Continent and the United States, coupled with protective tariffs, and not to the superior quality of iron produced, or, to any great extent, to the cheapness of labour in foreign countries. The introduction of the basic process of steelmaking has enabled Germany to largely extend its steel manufacture. As we know, German manufacturers successfully competed in England for orders for heavy steel castings, in which they have been able to use basic steel. Sir Lowthian also stated that "workmen were getting all the profit and the iron manufacturer none," a statement in which he was confirmed by Mr. Josiah T. Smith. Sir Lowthian Bell also considered that German increase had been assisted by "great natural facilities assisted by the import duties;" and Mr. Donaldson stated that "the present depression had been intensified by the tariffs existing against us," which had resulted in closing the American market particularly, and the German, French, and Russian markets to a large extent. It is, as the report states, satisfactory to know that we continue to hold in the neutral markets of the world "the most favourable place of any nation."

With regard to the cotton industry, the same remarks would seem to apply, as it is stated that in its various branches we are fully able to compete with the production of other nations, and this is especially the case with staple goods. The increasing competition of the Bombay mills, a feature to which we have before drawn attention in the columns of ENGINEERING, is also referred to by many of the witnesses. In this trade, also, the evil influences of foreign tariffs on British trade is an important feature.

With regard to the shipping industry, we cannot do better, by way of summarising the evidence tendered, than quote a paragraph from the majority report: "The evidence tendered to us on behalf of the shipping industry, went far to corroborate that given by the manufacturers and traders. In the volume of trade carried in British vessels there appears to be no falling off, but the tonnage built in recent years being in excess of the requirements of trade profits have been much reduced. There was also a general agreement that British shipping has as large a share as formerly of the carrying trade of the world, but that owing to the opening of the Suez Canal our entrepôt trade has fallen off."

THE SOCIETY OF TELEGRAPH ENGINEERS.

THE winter session of the Society of Telegraph Engineers and Electricians for 1887 was opened on the evening of Thursday, January 13, by the delivery of the inaugural address of the new President, Sir Charles Bright. This being the jubilee year of the electric telegraph, the President's subject was in a measure marked out for him, since it was evident that a *resumé* of the progress of electrical engineering science during the last fifty years would be appropriate.

Sir Charles Bright began his address by referring to the growth of the Society, which at its first meeting in February, 1872, numbered only 110 members, but which now numbers 1343. After referring to the earlier proposals for founding an electrical society in England, and the institution of one in June, 1837, which was entitled "The London Electrical Society," the President dwelt upon the success of the Society of Telegraph Engineers, whose members are now to be found in every part of the world. The motto of the Society might, he remarked, be "*Quæ regio in terris nostri non plena laboris.*"

Sir Charles then sketched the rise of the telegraph in the hands of Cooke and Wheatstone, and the memorable evening of July 25, 1837, when these gentlemen tried the line between Euston and Camden Town, which is to be regarded as the first practical electric telegraph in this, if not in any country. The capture of Tawell, the murderer, through the agency of the Paddington and Slough line, was next described, and the impulse which it gave to the young invention.

By the end of 1845 the single and double needle instruments of Cooke and Wheatstone were widely used. The Electric Telegraph Company was founded in 1846 and acquired the patents of Bain, including his chemical telegraph which Sir C. Bright saw "working at an astonishing speed between Manchester and London." Sir Charles considers Bain's telegraph to have been the father of the rapid automatic instrument of Wheatsone and Stroh, which is now used in the Post Office, and can transmit at the extraordinary rate of 435 words a minute.

The history of the Electric Telegraph Company was then followed by the President, and the rise of rival companies narrated, including the Magnetic Company, of which he himself was engineer. The introduction of gutta-percha into England in 1843 by Dr. Montgomerie, of the Indian Medical Service, who had observed its use by the Malays for basins and other domestic articles, paved the way for insulated wires and led to the construction of the first submarine line cable laid between Dover and Cape Grisnez on August 28, 1850. The credit of this enterprise he considered due to the late Mr. J. W. Brett, but in January of the preceding year (1849) the late Mr. C. V. Walker had laid a length of two miles of gutta-percha coated wire in Channel waters, starting from the sands near the Pavilion Hotel at Folkestone. These successes naturally led to the first Atlantic cable of 1858, with which the President himself was honourably connected, and to the subsequent more successful attempts to put the New World into electrical communication with the old.

This, however, is matter of more recent history, and we need not dwell upon it here. The address was listened to by a crowded meeting.

ARTILLERY IN THE UNITED STATES.

(FROM OUR NEW YORK CORRESPONDENT.)

IT is not a very pleasant thought for an American that the United States has no sea coast defences, no navy, and no guns worthy of the name. But that this is practically a fact no intelligent American can deny for a moment. We are wealthy, have a treasury surplus we do not know what to do with, and yet owing to the bickerings of political factions in Congress we are in the above condition. The very wealth of which we boast is an attraction which may tempt the cupidity of others, and indeed some of the smaller powers could inflict an injury on New York City, which their whole territory would not repay. Under these circumstances there is much interest felt in heavy ordnance; many experiments are being made at Sandy Hook, but it is greatly to be feared that both army and naval experts are so hampered by old methods and set ways of doing, which, like the laws of the Medes and Persians, "alter not," that they will not be fully abreast of the times and the demands of the day.

One of our Western papers calls on the Government to abandon its costly experiments with "built-up" guns, and cites the explosion of the 43-ton on your Collingwood as an evidence of their unreliability. It is stated also that the Krupp "built-up" gun has failed, and the testimony of steel manufacturers seems to bear on the point that large masses are subjected to such internal strains as to make them unreliable. The Whitworth gun is another instance, if one was needed. The Western journal declares that built-up guns burst because, like the razors that would not shave, they are built "to sell." The writer noted the behaviour of the Parrott guns during the late war, and even in the comparatively early stages of the knowledge of the properties of metals, the results were in the main extremely satisfactory. So far as his observations went, a Parrott gun never bursts unless by a premature explosion of the shell, and in the case of the 30-lb. Parrotts some 8000 to 10,000 shots were fired, and the guns are now in the Government service, and comparatively in good order. The 100 lb., 200 lb., and 300 lb. Parrotts did not show such service, but they were hastily constructed to meet an emergency, and no doubt the rifling was defective, and quite likely the grooves in the base of the shell were also not true, so that the least checking in the progress of the shell in the gun would throw forward the plunger, and explode it, with the result of either rupturing the gun or seriously impairing it. There is, so far as known, no record of a Parrott gun bursting except where a percussion shell was the projectile. That a total physical change will occur in metal after casting is well known. A distinguished officer of the English army, who has studied these problems, stated to the writer that the extreme changes in temperature during the day and night in India had, in his judgment, been the cause of deterioration in heavy built-up guns on your fortifications, where the sun's rays beat down all day upon them, and the cool night wind reduced the temperature again, thus gradually altering the molecular arrangement of the metal in the reinforces and rings, and weakening or destroying the elaborate artificial tensions set up in the manufacture, on the permanence of which such pieces depend entirely for their safety.

This subject will now be treated in an expert manner in the United States, and our old friend Mr. Dorsey is again at the front. Mr. Dorsey seems to be of an aggressive character, and manages to collect and assimilate a large mass of information and statistics on various subjects of interest to engineers. Learning that he was to read a paper on "Steel for Heavy Guns" before a distinguished

body of naval experts at the United States Naval Academy, Annapolis, Md., on January 5, and as the discussion is likely to be of interest in England, the writer obtained by diplomacy a proof of the advanced sheets which is laid before your readers. Mr. Dorsey some time ago asked our Ordnance officers in public print why they selected to withstand the strains and shocks of artillery use, steel which no engineer would put into a boiler, beam, or bridge, and Mr. Dorsey will always be found to have the courage of his convictions. Any opponent who enters the lists against him had better not have any defective joints in his armour, or this engineer's keen eye will quickly detect them, and his trenchant blade will speedily shear through the place. Mr. Dorsey's paper* is more of an introduction to the subject, and to use a technical phrase, is a "preliminary skirmish;" the real battle will follow, and in its result England is as much interested as the United States in this question.

LITERATURE.

Tabulated Weights of Iron and other Metals for the Use of Engineers and Draughtsmen. Compiled and Arranged by G. M. MAY. Second Edition. Revised and Enlarged. Published by the Author at Brampton, near Chesterfield. [4s.]

THIS volume is of a convenient size, and is printed very clearly, a most important point where tables of figures are concerned. Among other things, it contains pages of decimal multipliers for the conversion of quantities expressed in one denomination into others, such for intances as cubic inches into cubic feet, cubic yards, pints, quarts, gallons, bushels, and pounds of water; also multipliers for finding the equivalent weights of areas and volumes of nine different metals. Separate tables are given for rolled and hammered iron throughout the book. Steel bolts and nuts from $\frac{3}{8}$ in. to 2 in. in diameter, and from 1 in. to 12 in. long, form the subject of another table. The weights of the Broughton Copper Company's brass and copper tubes is given, as is also that of Russel's homogeneous boiler tubes, and steam and gas tubes. In connection with the latter the addition of the weight of the fittings strikes us as new. The thickness of brass and copper tubes are given in imperial wire gauge, and the diameter in millimetres and in inches. The weights of sheet metals are given for thicknesses in imperial wire gauge, in sheet and hoop iron gauge, B.G., issued by the South Staffordshire Ironmasters' Association. Steel hoops, rivets, and cylinders are treated separately from the same manufactures in iron. In addition to the points we have noticed, the work contains all the usual tables, and from its handy arrangement should prove popular.

The Watch and Clockmakers' Handbook, Dictionary, and Guide. By F. J. BRITTON. Sixth Edition. London: W. Kent and Co. New York: E. and F. N. Spon. 1886.

The fact that this work has attained its sixth edition is evidence that the author understands the wants of the class whom he addresses. Ordinarily the plan of arranging information alphabetically is objectionable, as considerations of space involve many of the subjects being treated very cursorily, and the habit of writing thus formed, is apt to make itself visible in matters which demand careful treatment. This defect appears to have been avoided in this case, and many of the notices are full of detail and are addressed to working watchmakers, who would be the first to detect any inaccuracies. A feature which appears for the first time is a vocabulary of French and English, and German and English equivalents for the different terms used in clock and watchmaking. There are also a good many new illustrations, and descriptions of tools which have appeared since the issue of the previous editions. American practice is also alluded to in some cases, and the work has been generally brought up to date.

Fire Protection of Mansions. How to Prevent Fires and how to Extinguish them. With Practical Remarks upon Water Supply and Fire Apparatus. By JAMES COMPTON MERRYWEATHER, M.I.M.E. Second Edition. London: Merritt and Hatcher.

The fact that a second edition of this work has been called for in little more than two years shows that it meets the needs of those who live beyond the protection of efficient fire brigades. We reviewed the book on its first appearance, and need only now call attention to the additions which have been made to it. We notice that the records of fires at country seats have been brought down to the present date, as have also the descriptions of the installations laid down by the author at various houses, both new and historic. A chapter has been added for the benefit of those whose dwellings are not of such a size or value as to warrant the provision of special fire-resisting appliances and two appendices have been inserted—one relating to oil lamps, and the second to the loss of pressure by friction in hose. There are in this country many priceless treasures of art, the existence of which depends upon mere good fortune—the fall of a match or the upset of a lamp might prove their destruction. To the owners of such this book is especially addressed, and it contains the lessons of thirty years spent in forestalling the fire-fiend.

A Treatise on Spherical Trigonometry with Applications to Spherical Geometry. Part II. By W. J. M'CLELLAND and T. PRESTON. London: Macmillan and Co., 1886.

THIS small volume is very unlike an ordinary treatise on "Spherical Trigonometry." It might well be called a treatise on modern higher spherical geometry, being, in fact, an extension of the modern higher plane geometry of the straight line and circle to a spherical surface. It is, therefore, too purely mathematical to be of much interest to practical engineers, but is of the highest interest to mathematicians. The headings of a few of the chapters will suffice to show the sort of subject matter, *e.g.*, Chapter IX., Concurrent Arcs and Concyclic Points; Chapter XI., Anharmonic Section; Chapter XII., Coaxal Circles, Centres and Axes of Similitude, and Spherical Inversion; Chapter XIV., Spherical Reciprocation. The analogy of all these with the corresponding plane geometry is extremely interesting. This small work, one of the earliest on this vast subject, will be welcomed by all mathematicians, whose only regret on closing it will be that it is too short. Some further developments which are promised (in the preface) will be awaited with interest.

BOOKS RECEIVED.

The Manufacture of Steel Carriage Springs. By JOHN S. FOGGETT. London: John Kemp and Co.

Expansion of Structures by Heat. By JOHN KEILY, C.E. London: Crosby Lockwood and Co. [Price 3s. 6d.]

Practical Handbook on Pump Construction. By PHILIP R. BJÖRLING. With Nine Plates. London and New York: E. and F. N. Spon.

The Mechanics of Machinery. By ALEX. B. W. KENNEDY. With numerous Illustrations. London: Macmillan and Co.

The Portable Engine; its Construction and Management. By WILLIAM DYSON WANSBROUGH. London: Crosby Lockwood and Co. [Price 3s. 6d.]

Transactions of the Sanitary Institute of Great Britain. Vol. VII. London: Edward Stanford.

Gas Fitting. By JOHN BLACK. With One Hundred and Twenty-one Illustrations. London: Crosby Lockwood and Co. [Price 2s. 6d.]

Vauban, Montalembert, Carnot; Engineering Studies. By E. M. LLOYD, Major, R.E. With Portraits. London: Chapman and Hall.

Safe Railway Working: A Treatise on Railway Accidents, their Cause, and Prevention. By CLEMENT E. STRETTON, C.E. London: Crosby Lockwood and Co. [Price 4s. 6d.]

Outlines of the Geology of Northumberland and Durham. By G. A. LEBOUR, M.A., F.G.S. Newcastle-upon-Tyne: Lambert and Co.

Electricity and its Uses. By J. MUNRO. Second Edition. Revised and Enlarged. London: Religious Tract Society.

Railway Problems; An Inquiry into the Economic Conditions of Railway Working in Different Countries. By J. S. JEANS. London: Longmans, Green, and Co. [Price 12s. 6d.]

Trusses of Wood and Iron. Practical Applications of Science in determining the Stresses, Breaking Weights, Safe Loads, Scantlings, and Details of Construction, with Complete Working Drawings. By WILLIAM GRIFFITHS. London: Crosby Lockwood and Co.

The Law and Practice Relating to the Prolongation of Letters Patent. By JOHN FRANCIS WAGGETT, M.A., Oxon. London: Butterworths.

Ornamental Turning; A Work of Practical Instruction in the above Art. By J. H. EVANS. With Numerous Engravings and Autotype Plates. London: Published by the Author, 159, Wardour-street, W.

The Manual of Lubrication; or, How to Choose and How to Use Lubricants. By LOUIS SIMPSON. New York: Oil, Paint, and Drug Publishing Company; Manchester: J. Andrews and Co.

GERMAN MECHANICAL INDUSTRY.—The profit realised by the Phœnix Company at Laar-Ruhrort, in 1885-6, was 52,268*l.*, as compared with 48,605*l.* in 1884-5. A dividend of 2½ per cent. has been paid for each year. In the course of 1885-6 the company expended 33,539*l.* in the improvement and reconstruction of its works.

NOTES.

A PERFECT SIMPLE PENDULUM.

DR. J. T. BOTTOMLEY, F.R.S.E., has devised a nearly perfect simple pendulum by suspending a lead shot from a single cocoon silk fibre in the vacuum produced by a Sprengel air pump. The shot was $\frac{1}{16}$ in. in diameter, and the fibre 2 ft. long. It was placed in a glass tube of $\frac{3}{4}$ in. internal diameter, and exhausted to one-tenth of a millionth of an atmosphere. The pendulum had a vibrational range of $\frac{1}{4}$ in. on each side of the mid position. The weight of the lead shot was $\frac{1}{3}$ gramme, but Mr. Bottomley is making a seconds pendulum 39.1 in. long, having a heavier weight, and to be inclosed in a better vacuum.

NICKEL CRUCIBLES.

Pure nickel is one of the toughest of metals, it fuses only at very high temperatures, and has a fine grain susceptible of high polish. These qualities have led to its being used for chemical crucibles and evaporating dishes. For many purposes they are quite as serviceable as platinum ones; and cost only one-tenth the price of platinum. They stand alkalis well, Mr. Wanklyn having found that there was no alteration of weight in the crucible after caustic potash was fused in it. Hydrochloric acid dilute or concentrated may be used in the cold to clean them, so also cold vitriol, but concentrated nitric acid attacks them. They can be used for taking water residues.

A NEW APPLICATION OF PHOTOGRAPHY.

A publishing house in New York has in preparation a dictionary upon which a number of specialists have been engaged for a long time, and although the loss in case of fire would be irreparable as far as the duplication of 25,000 pages of manuscript and illustrations are concerned, it would also inflict a great damage upon the publishers, who have already expended 150,000 dols. upon the work; so photography has been used for the duplication of the copy, reducing the manuscript pages of 10 in. by 12 in. to miniatures 1¾ in. by 2 in.; and these photographic negatives are stored in a place of safety outside of the publishing house. A number of pages are photographed upon a single negative, and the cost of the work amounted to only 300 dols., far less than any reasonable amount of insurance. If it even becomes necessary to use these negatives, they will be photographed by solar prints, and in this manner enlarged to any convenient size.

A RICH ENGINEERING LABORATORY.

In a recent issue of ENGINEERING we announced that Sir A. B. Walker had presented the magnificent gift of 15,000*l.* to endow the laboratory of engineering at University College, Liverpool. We now learn that Mr. Thomas Harrison, a Liverpool shipowner, has given the further sum of 10,000*l.* to endow the chair of engineering, which will be known in future as the Harrison Chair of Engineering. The same public-spirited donor had previously given 1000*l.* to the mathematical chair, and 500*l.* for other purposes. These sums make a total of 25,000*l.* received from two subscribers in the course of a few weeks. Probably other sums will be forthcoming, for Liverpool possesses many rich and public-spirited citizens, and the generous example of Sir A. B. Walker and Mr. Harrison will doubtless bear fruit. There are few cities in the United Kingdom that owe more to the science of engineering than Liverpool, and we may add there are few engineering chairs more promising than that filled by Professor Hele Shaw. We hear also that Mr. George Holt has given 1000*l.* to the library and 500*l.* to the sustentation fund.

THE GOLDFIELDS OF BURMAH.

The gold formerly found in the alluvial deposits of Lower Burmah is believed to be exhausted, but the metal is still found on the Chundwin in Upper Burmah, and it is stated that platinum is found there also. Dr. Romanis has recently examined two specimens of gold received from Mr. R. C. Stevenson, of Mya-daung, which were found westward of Kattia, about thirty miles from the Irrawady, on the banks of the Meza, in the territory of Wimtho Isawbwa. One specimen was said by a native to have been found in the bed of the Meza, the other at the foot of a range of hills. The first specimen contained 87.66 per cent. of gold among silver, copper pyrites, quartz, and magnetic oxide of iron. The second specimen contained 74.83 per cent. of gold among silver, platinum (2.53 per cent.), iridosmine, zirconia, and silica. The methods of working by the natives consist either in turning a

* [We print this paper on page 69.—ED. E.]

stream aside for a time into a channel and washing the deposit, or digging a long ditch before the rains, and washing the bottom after the floods have subsided, or, thirdly, by sinking shafts in the auriferous strata, from 7 ft. to 30 ft. below the surface, and tunnelling laterally for a few feet. The output by these methods is small, but might be increased by hydraulic working.

Coal in Sweden.

From statistics just published it appears that the output of coals in Sweden is steadily increasing, and in several quarters hopes are entertained of a further and still more important development. We give the figures for a few years:

	cubic feet.
In 1872 the total output was ...	2,406,466
,, 1875 ,, ,, ...	3,066,981
,, 1878 ,, ,, ...	4,429,889
,, 1880 ,, ,, ...	4,817,759
,, 1882 ,, ,, ...	6,842,998
,, 1883 ,, ,, ...	7,304,804
,, 1884 ,, ,, ...	7,873,237
,, 1885 ,, ,, ...	8,313,821

Five localities have been worked, of which Höganäs heads the list:

	cubic feet.
Höganäs...	2,632,641
Vallakra	2,442,714
Krapp	2,124,122
Skromberga	1,051,542
Baserup...	62,805

The number of hands employed in the coal mines amount to about 1200.

"Goliath" Rails.

Some time ago* we called attention, in connection with a paper read by Mr. C. P. Sandberg before the Institution of Civil Engineers, to the inadequate weight of the rails used on the Continent, and we insisted that the growing dimensions of the traffic required that this feature of railway economy should be regarded not only from the standpoint of present needs, but also with a view to the increased speed of travelling demanded by the public, and enforced by the competition of the leading lines. We are glad to learn that the views which we then set forth are finding acceptance in Belgium, and that rails of exceptional strength are to be laid down by the administration of the State Railway on certain busy parts of their system. The Société Cockerill is rolling some hundreds of tons of rails, weighing 50 kilogrammes per metre (101 lb. per yard), and known as "Goliath" rails. These are of the Sandberg section, slightly modified by M. Flamache, and are intended to be laid down on a section over which it is designed to run trains at a higher speed than hitherto attained. If the experiment proves successful it is hoped that the journey from Brussels to Antwerp will be reduced to half an hour, and that on the Ostend-Verviers line the journey will be effected in three hours. This, together with the improved service from Dover to Ostend, will greatly shorten the time of travelling from Belgium to London.

A Belgian Steamer for the Congo.

The John Cockerill Company has just completed a small stern-wheel steamer, which has received the name of the Ville de Bruxelles, and which is intended to ply on the Upper Congo or its affluents from Leopoldville to Stanley Falls. The Ville de Bruxelles was specially ordered by the Government of the Congo. She is 84 ft. 1½ in. long, 18 ft. 4 in. beam, and 4 ft. 6¾ in. deep. The engine is placed in the stern, while the boilers are placed forward; the boilers being of mild steel, and worked at a pressure of ten atmospheres. The Ville de Bruxelles is built entirely of wood, so that her hull slightly exceeds in weight a steel hull of similar size. Several reasons have induced the Government of the Congo to order a wooden vessel. One of these reasons is the greater ease with which a leak may be made good in a wooden, as compared with a steel or iron hull, while it is also easier to train natives in working wood than in working metals. The Government of the Congo has some idea of using the Ville de Bruxelles as a pattern from which other vessels may be built on the spot. There is an abundance of timber on the banks of the Congo, and sundry waterfalls might be utilised for the establishment of sawmills at little expense. In a trial trip made by the Ville de Bruxelles on the Scheldt she attained an average speed of nearly 8¼ knots per hour, the engines working up to 60 horse-power, and making 38 revolutions per minute. The Ville de Bruxelles will be shipped in pieces, and will be carried overland from Boma to Leopoldville. She is expected to be ready for service at Leopoldville in the course of the summer.

* Vol. xli., p. 501.

Locomotive Crank-Axles.

The failure of crank-axles is one of the most important questions that requires the attention of locomotive engineers, and some particulars of breakages on the Northern Railway of France, which are quoted in the current volume of the Proceedings of the Institution of Civil Engineers, will be read with interest. The details are taken from the *Annales des Mines*, vol. ix., page 335. The period embraced extends over the five years between 1881 and 1885, during which time there were fifty-eight cases of breakages; one in the bearings, five through the webs, and fifty-two through crank-pins. During the same period 100 axles were condemned. These figures show the crank-pin to be in general the weak spot, and this is of course in accordance with ordinary experience. It is suggested that by drilling an axial hole 2⅜ in. in diameter through each crank-pin it would be weakened to a very slight extent, while the insertion of a bolt would add enormously to its safety. Such a bolt would be subject only to sheering strain, and its full area would therefore be efficient. This plan would necessitate no extra room, which is an important point, for though the crank-pins might be increased in diameter the practice would be inconvenient on account of the additional size of big ends that would be required, and the consequent raising of the boiler. It is said that the cost of drilling and bolting two crank-pins would be 1*l.* 12s. The cost of shrinking four hoops on to the crank webs to strengthen those parts is set down at 5*l.*

American Metallurgical Industry.

The production of pig in the United States during the past six months is estimated at not less than 3,000,000 tons, and the output in the first half of 1887 is also expected to be upon a large scale. The price of foundry pig at Philadelphia at the commencement of each month last year was as follows: January, 18¾ dols. per ton; February, 18¾ dols. per ton; March, 19 dols. per ton; April, 19 dols. per ton; May, 19 dols. per ton; June, 18¾ dols. per ton; July, 18⅝ dols. per ton; August, 18⅝ dols. per ton; September, 18⅝ dols. per ton; October, 19 dols. per ton; November, 19¼ dols. per ton; and December, 20 dols. per ton. It will be seen that prices were at their highest point at the close of the year. The production of steel rails in the United States in 1886 is estimated at about 1,250,000 tons. The productive capacity of the rail rolling mills in 1887 is estimated at about 1,750,000 tons, the contracts received footing up to 1,000,000 tons. The price of steel rails at Philadelphia at the commencement of each month last year was as follows: January, 34¾ dols. per ton; February, 34¾ dols. per ton; March, 34¾ dols. per ton; April, 34¾ dols. per ton; May, 35 dols. per ton; June, 34¾ dols. per ton; July, 34¾ dols. per ton; August, 35 dols. per ton; September, 35 dols. per ton; October, 34¾ dols. per ton; November, 35 dols. per ton; and December, 36 dols. per ton. Here, again, it will be seen that prices were at their highest point at the close of the year. Not only is there an active demand for rails at present in the United States in consequence of the increased vigour prevailing in the American interest, but the principal shipyards are also busy. Large mechanical concerns, such as the Baldwin Locomotive Works, further report that they are well off for orders.

The Lowe Incandescent Gaslight.

The Lowe incandescent gaslight was recently exhibited by the Lowe Manufacturing Company, of Norristown, Pa., U.S., at the "Novelties" Exhibition of the Franklin Institute. It is produced by allowing non-luminous water gas to impinge on a spiral wire of platinum-iridium or platinum. Several forms of the burner are used. Those shown at the exhibition and examined by the judges were formed of a stout wire of horseshoe shape, the ends of which were attached to a brass collar, and snugly fitted on the ordinary lava-tipped slit burner. On this stout wire was tied by means of a fine wire of the same material a close spiral of the platinum or platinum-iridium, the stout supporting wire being placed on the upper or outer surface of the curve formed by the spiral. The size of the horseshoe varies with the size of the burner on which it is intended to be used. They were shown singly or in groups or clusters upon chandeliers of the ordinary pattern, and in tastefully decorated rooms. The adjustment of the spiral is such that every part of it may be equally heated. For this the alignment of the spiral with regard to the flame must be perfect, and the orifice from which the flame issues must be kept free from dust, otherwise the unequal brightness of the spiral becomes at once apparent. The Lowe Manufacturing Company claim to have had 2000 hours of service from experimental burners of this type without appreciable deterioration. The jury from tests made arrived at the conclusion that for the Lowe incandescent light to compete with ordinary illuminating gas, it will have to be supplied with gas at two-fifths the cost of illuminating gas. Whether this can be done or not the jury refrain from expressing an opinion, but they have awarded a silver medal to the Lowe Manufacturing Company. They were favourably impressed with Mr. Lowe's production of water gas as a fuel for cooking, baking, heating, and so on in restaurants and houses. The water gas is made by the interaction of steam and carbon at a high temperature, and is composed essentially of hydrogen and carbonic oxide.

Labour in New South Wales.

The application of the representatives of the local iron trades in New South Wales, mentioned in our article on "Australian Industries" in the issue of December 24, to the Minister of Public Works, appears to have been followed by a deputation of unemployed mechanics, who laid their case before the Premier. Their demands were far more drastic than those of their employers, and comprised relief works for mechanics only, total cessation of immigration, and protection. The first request raises the veil from a very amusing feature of democracy. It seems that when the ordinarily well-paid and self-important mechanic is forced by the pressure of hard times to join company with labourers and navvies, and turn to unaccustomed labour, these latter take advantage of their opportunity to assert their temporary superiority. The mechanics object to this inversion of what they consider the order of providence, and consequently they ask that separate relief works may be organised for their exclusive use. This is, however, only a small matter. But the cessation of immigration is a totally different affair in a colony whose two greatest needs are population and capital. Is it to be supposed that capital can be attracted to a country which is closed against labour? and without capital how are the workpeople already in the colony to have their families provided for? Already the restriction on the importation of South Sea Islanders and the refusal to permit the importation of coolies is bearing a fruit which these anti-immigrationists cannot escape tasting. The sugar planters, whose work can only be performed by coloured labour, finding the supply cut off, are restricting their operations. Consequently fewer mechanics are wanted on the plantations, while the constant repairs and odd jobs which formerly kept many of the local engineers busy, have practically disappeared. Thus the cessation of a non-competing immigration has reduced many of the artisans of Sydney to starvation. Mechanics bid fair to become the curse of some of our colonies. They refuse to settle on the land and develop the natural resources of the country, but instead of this they keep to the towns, and oblige the Government, for they are politically very strong, to pile up the indebtedness of the community in order to execute public works on a magnitude far beyond the need of the time.

Chambers of Commerce and Indian Railways.

Sir James Bain did good service at Glasgow this week in insisting, before the local Chamber of Commerce, on the importance of railroads for India. The theme is an old one, but not only are the public, but the present Government in office also, apparently indifferent to the importance of the question to the two countries concerned. We have materials for railroads we want to sell, and capital lying idle in the banks for want of opportunities of investment. India, on her part, has provinces with populations as large as the population of the United Kingdom waiting to be opened up by railroads, and resources which would enable a fair dividend being paid on those railroads if they were only completed. Why cannot the two be brought together? If the railways were made, not only would the iron trade lose some of its depression and dead capital get into circulation, but the basis would be laid in India for other developments of business. To quote an instance, India, by the development of railways, has been able to become a corn-exporting country, and

send to Europe wheat to the value of 4,000,000*l.* or 5,000,000*l.* a year—does not a large proportion of that money come back to this country in new demands for manufactured goods for the Indian people? Who will dispute that if we spend a million sterling on Indian wheat, instead of on the Russian or American article, more of the money returns to our pockets again, in shape of traffic receipts on the Indian railways and orders for English goods? Yet railway construction in India is proceeding at a very slow pace, and the Chambers of Commerce make very slight efforts to question it. What is wanted of the chambers is more pressure on the India Office, where heartbreaking obstructions are placed in the path of enterprise. Recent changes in the composition of the Indian Council have rid it of some fossils, but as yet there have been no indications of a real desire to give every help to the development of the Indian railway system. We trust that now the matter has been discussed by the Glasgow Chamber of Commerce other corporate bodies will co-operate to make the India Office feel that the public will not patiently tolerate obstruction much longer. It is intolerable that highly-paid officials and place-hunting politicians should check business in any way at a moment when so many hands are idle in this country.

The "Petriana" Verdict.

The verdict of the jury at Birkenhead, in regard to the explosion of petroleum gas on board the Petriana, has proved so clear and satisfactory that it has set at rest all public uneasiness with respect to the bulk system. We believe we are correct in saying that the jury embraced a number of persons who, if they knew little about the transport of oil in bulk, were thoroughly acquainted with the petroleum trade. Their decision was, therefore, of an authoritative character; and all the more so, because the petroleum trade in general has a conservative dislike to the new system of transport, and probably more than one juryman entered upon his duties with a prejudiced mind. The evidence, however, was so plain and so convincing as to leave no room for discussion and doubt. Certain stringent rules existed on board the vessel, prohibiting the use of the naked light. Up to the very moment that the ill-fated party of gentlemen descended into tank No. 6, those regulations were enforced with a severity that must have produced discomfort on the part of the labourers and rivetters at work. The infringers of the safety regulations were cautioned before going below, but apparently not understanding the real character of the risks they ran, they disregarded the warning of Messrs. Clover's foreman. The result was, that when pressure was applied in testing the tank and the oil and gas floating on the surface of the water "sprayed" through a defective rivet hole, conditions were set up favourable to an explosion, quite foreign and exceptional to the normal conditions prevailing on a carefully handled petroleum ship. The danger would have been just as great on a wooden vessel laden with leaky barrels, and would have never developed into a catastrophe if ordinary care had been observed. We are glad that the jury accepted this view and ascribed no fault to the bulk system, because its introduction and development implies too much work to the engineering trade to be trifled with. In a preposterous article in the Liverpool *Journal of Commerce*, a few days ago, all manner of imaginary dangers were dilated on, and the writer seemed to consider the Petriana the first of its class afloat. As a matter of fact, according to a letter by Mr. Charles Marvin, in the *Newcastle Chronicle*, upwards of 2000 voyages have been performed by the 100 tank steamers in the Caspian, without any serious mishap, and if this does not afford a convincing argument in favour of the general safety of petroleum tank steamers we should like to know what further evidence a doubting critic would desire.

Forced Draught for Marine Boilers.

It is satisfactory to know that some material progress is being made in the application of the system of forced draught in the mercantile marine. Especially is this true as regards the engineering practice on the Clyde. The screw steamer Ohio, belonging to the International Navigation Company (now amalgamated with the new Inman Company), and engaged in the Liverpool and New York mail and passenger trade, has lately arrived in the Clyde for the purpose of being entirely refitted with new engines and boilers by Messrs. James Howden and Co., of Glasgow, the boilers to be worked on the forced draught system, which was successfully brought into operation by that firm upwards of three years ago. The important advantages of that system have been amply demonstrated by continuous working on long voyages during the greater part of that period. The steamer New York City, one of the "Direct" West India Liners, owned by Messrs. Scrutton, Sons, and Co., was fitted with a new boiler on the "Howden" forced draught system in the autumn of 1884, and she has been running continuously since then with the utmost efficiency and with an economy in fuel which is believed to be the highest yet attained in any steamer afloat, though the engines are only of the ordinary compound type, with the boiler pressure only 80 lb. This system of working marine boilers increases the propelling power of the engines, while it admits of the weight of the machinery being reduced, as also the amount of space occupied by it—thus adding to the cargo-carrying space. It also gives very great economy in fuel. These advantages are now being practically recognised by some of the leading and most conservative shipowning companies. The Ohio is the first of the steamships belonging to the International Company to be refitted according to the most recent notions in marine engineering practice; and in order that she may have the fullest benefit of the forced draught system, she is also being supplied with new triple-expansion engines. Messrs. Howden and Co. are just finishing the refitting of Messrs. George Smith and Sons' steamer City of Venice with new high-pressure boilers on their system of forced draught, the engines at the same time being adapted to the principle of quadruple expansion, according to Mr. Howden's patent arrangement. The same firm have also under construction two sets of triple-expansion engines of from 1200 to 1400 indicated horse-power, with boilers working on the patent forced draught system and at a steam pressure of 160 lb. per square inch. These engines and boilers are for two new steamers now building for Messrs. Robert MacAndrew and Co., of London, who have already had most satisfactory experience with triple-expansion engines and forced draught boilers working at the pressure just mentioned. Messrs. Howden and Co. have spent much trouble and expense in successfully overcoming the practical difficulties connected with the use of forced draught in steam boilers, and they can now confidently look for some reward.

NOTES FROM THE SOUTH-WEST.

The Welsh Coal Ports.—The total shipments of coal and coke last year from Cardiff, Newport, and Swansea were as follows: Cardiff, 7,329,087 tons; Newport, 3,065,745 tons; Swansea, 1,481,929 tons. These figures, when compared with the corresponding returns for 1885, exhibit a decrease of 444,231 tons in the shipments from Cardiff; an increase of 166,438 tons in the shipments from Newport; and a decrease of 4561 tons in the shipments from Swansea. Adding Llanelly, we find that the foreign coal shipments from the South Welsh ports in 1886 amounted to 9,495,313 tons. In 1880, the corresponding shipments stood at 6,804,108 tons.

The Timber Trade at Cardiff.—Messrs. Alexander and Co., timber merchants, of Cardiff, have received a communication from the London and North-Western Railway Company stating that in future the charge of that company for delivery, off canal, on timber and deal traffic from Cardiff to Birmingham and the South Staffordshire district, will be 10d. per ton with those places where the station-to-station rates include delivery of the coal. The haulage rate has thus been reduced to the same figure as that of Bristol, and one of the serious stumbling blocks to the timber trade of Cardiff has been removed.

Barry Dock and Railways.—The earthworks for the Penarth line have been commenced. This line will branch from the main railway at Cadoxton-juxta-Barry, run across the Dinas Rewis moors past Eastbrook, and join the Taff Vale Railway at Cogen Pill, north of Penarth Dock Station. The only work which will be proceeded with this winter is a long cutting in dry material between Cadoxton and Biglis Farm; the remainder will be put in hand in the spring. Mr. J. Robinson, the resident engineer of the dock works, will have charge of the construction of the branch. Mr. T. A. Walker is the contractor.

Keyham.—Between fifty and sixty men have received notice of discharge from the steam branch of Keyham Dockyard. They consist of fitters, millwrights, pattern makers, and coppersmiths. Twelve labourers who were to be discharged are to be transferred to the constructive department.

Water and Drainage at Brixham.—Mr. S. J. Smith, C.E., inspector of the Local Government Board, held an inquiry at Brixham on Wednesday in reference to an application for powers to borrow 3050*l.* for works of water supply and street improvement. Mr. Ellis, C.E., produced plans of the town in which the proposed improvements were shown. It was stated that the present water supply was sufficient for all purposes for the low-lying parts of the town, and that it was now proposed to provide means for forcing water to a height of 63 ft. above the present level by means of a steam engine during four months of the summer. During the wet season it can be carried to the desired elevation by force obtained from the existing supply with the assistance of a water wheel.

Newport Harbour Commission.—The monthly meeting of the Newport Harbour Commission was held on Friday, Colonel Lyne presiding. The chairman stated that the question of a breakwater was under the consideration of the Alexander Dock engineer, who was preparing a report and plan, which would be ready as soon as Sir George Elliot returned home.

Cardiff.—The steam coal trade has been active during the last few days, last week's shipments having amounted to nearly 160,000 tons. Quotations, however, still remain at an unremunerative level. Small steam coal has been in pretty good demand at 4s. 6d. per ton. The manufactured iron trade has presented a better tone. The exports of rails have not been very large, but the works are pretty well employed, and large orders for rails are anticipated from the United States. Stocks of iron ore are stated to have been reduced at the works.

The Forest of Dean.—Since the opening of the Severn Tunnel, new markets have been found for the coal of the Forest of Dean, and trade has become more active in consequence. For a long time past the Dean Forest Collieries have worked but one shift per day, but one large concern has commenced a double shift per day, and some of the other local coalowners are expected to follow this example. The manufactured iron trade of the Forest of Dean has shown depression. This is attributed, to some extent, to severe German competition.

Bristol Naturalists' Society—Engineering Section.—The inaugural meeting of this recently formed section has just been held at University College. Mr. Charles Richardson was elected president, and Mr. J. W. J. Harvey vice-president for the current session. Messrs. Ryan, J. Watts, G. Newall, G. W. Sutcliffe, F. J. de Soyres, and P. B. Gross, were appointed members of the committee. Mr. N. Watts was elected hon. secretary and treasurer. It is hoped that by the formation of an engineering section a means will be provided for bringing together the local engineers for the advancement of science and for social and professional intercourse. The hon. secretary (address Bank-buildings) will be glad to receive the names of persons willing to join the society and section.

Nettlefolds (Limited).—The extensive works which this company has erected at Rogerstone, near Newport, have now reached a sufficiently advanced stage to admit of a trial of the machinery. This trial was made on Saturday, when some horsenails and wire was turned out. About 60,000*l.* has been expended on the works, which have already secured a good many orders.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Steel Rails.—The Manchester, Sheffield, and Lincolnshire Railway Company is inviting tenders for 10,000 tons of steel rails. This is sure to lead to much local competition.

A New Trent Scheme.—A scheme is on foot for the purpose of developing the communication by water between the estuary of the Mersey and the Humber, the success of which will have great effect in fostering trade in this district of the Midlands. An influential syndicate has been formed to further it. The river is now navigable up to a place known as Derwent Mouth, whence communication with the Mersey system begins by means of a canal belonging to the North Staffordshire Railway Company, this presenting the only available means of transporting traffic by water between Burton-on-Trent *vid* Gainsborough to Hull. The Trent Navigation Company are quite inadequate to provide efficient accommodation for the traffic which will pass over the Trent if the scheme is carried out, and it is intended to dissolve the present company and incorporate a new one with increased capital and powers, the capital being 350,000*l.* The proposal is to enlarge the whole course of the river, so that at all times of the year vessels drawing 6 ft. of water can run between Liverpool and Hull.

Threatened Strikes of Miners.—The miners of Monk Bretton Colliery have resolved that unless certain arrangements are made as to wages, a strike is inevitable. Mr. Pickard, M.P., is endeavouring to settle the dispute. The men at East Gawber Colliery, near Barnsley, have given in notice to leave work in fourteen days, in consequence of alleged non-payment, according to the price list. Several hundred workmen will be affected by the notices.

Yorkshire College Engineering Department.—A meeting of the Yorkshire College Engineering Society was held on Monday evening in the Engineering Lecture Room, the Hon. R. C. Parsons, in the chair. A short address on "Punching and Drilling" was given by Mr. J. H. Wicksteed, followed by a discussion in which the President, Professor A. Barr, the chairman, Messrs. Hartnell, Dolby, and others, took part. The adjourned discussion on the "Compound as compared with the Simple or Normal Locomotive," the subject of the paper given by Mr. W. Cleland, B.Sc., demonstrator in the Engineering Laboratory, at the December meeting, was next proceeded with, the chairman and many members taking part.

The Artesian Well at Gainsborough.—The Gainsborough Local Board are receiving the first spark of encouragement in their boring for water on the artesian well system. The geologists have been proved to be wrong, so far as their prognostications went with regard to the depth of the

stratum of blue marl, over 100 ft. having been penetrated below the depth as suggested. The red sandstone has at last been reached, but there is no water as yet. The bore is down 770 ft., and has already cost a large sum of money.

The New High Peak Railway.—It has been proposed by the London and North-Western Railway Company that in the making of the High Peak Junction Railway, there should be a viaduct placed across Spring Gardens, which is one of the principal thoroughfares of Buxton. Many members of the local sanitary authority consider that this would seriously disfigure the main entrance to the town, and others advocate the opposing of the line on the ground that if it is simply for lime traffic, the town will be inundated with dust. The Local Board has decided not to give sanction to anything in the way of plans until they have been duly and fully submitted and considered by the whole Board.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a large attendance on 'Change at Middlesbrough, and a fair amount of business was done. No. 3 Cleveland pig iron for prompt delivery was quoted 38s. 3d. per ton, and for delivery over the next few months 38s. 9d. was the price. The reports from all the iron centres, both at home and abroad, continue of a very satisfactory character, and especially is this so with regard to America. Large orders are still being placed for all classes of iron and steel for the great continent across the Atlantic, and there is reason to believe that the demand will increase. The hematite pig iron trade is firm, and prices for east coast brands are quoted nominally about 50s. per ton, but makers are unwilling to sell at present owing to the substantial rise in the prices of ore and the rates of freight. There is nothing new in the manufactured iron trade. Many of the works are still badly employed, but in sympathy with the advance in the quotations of crude iron prices are firmer. Ship-plates are quoted 4*l.* 15s. per ton to 4*l.* 17s. 6d., and angles 4*l.* 10s. to 4*l.* 12s. 6d. Steel ship-plates are 6*l.* 10s. and angles 6*l.*, less 2½ per cent. at works. Steel rails are firm at 4*l.* 10s. to 4*l.* 12s. 6d. per ton f.o.b.

Engineering and Shipbuilding.—Engineers and iron-founders continue to receive fair orders on foreign account, and shipbuilders are finding more to do, as the improving freights are inducing shipowners to build new steamers. One of the oldest engineering firms on the Tyne have received an order for about 2000 tons of bridgework for Japan. Marine engine builders on the northern rivers are getting busier, and Messrs. T. Richardson and Son, of Hartlepool, are very busy on triple-expansion engines.

The Steel Trade.—All the works continue busy, and are preparing for still further activity. Most firms have orders which will occupy them fully for several months. The men at some of the steel works are discussing the wages question, and are expecting an advance. It is not anticipated that there will be any strike or stoppage of work, as the workmen will be allowed to share to some extent in the improved prices. The steelworkers are endeavouring to form a strong union. It would be well if they would federate with the ironworkers, and assist to enlarge the powers of the Board of Arbitration, which for years has been the means of amicably settling all labour and wages questions in the manufactured iron trade.

The Coal and Coke Trades.—Coal is steady and coke is firm. Every effort is being made to arrange the wages dispute in the Northumberland coal trade, and it is still hoped and believed that it will be arranged without a strike. A stoppage of work about wages or labour disputes should not be possible, and certainly would be avoided if the Board of Arbitration were reorganised and made more comprehensive.

MISCELLANEA.

AT a meeting of MacLaine's Patent Perfect Piston Company, Limited, held on January 14, at Belfast, a dividend of 100 per cent., free of income tax, was declared for the past year.

Mr. W. H. White, Director of Naval Construction, will deliver this evening a lecture on "Modern War Ships" at the Mansion House. Lord Charles Beresford will preside. The lecture is the third of a course which has been arranged by the Shipwrights' Company.

At a meeting of the Jubilee Ocean Race Committee, it was arranged that the course for the race for 1000*l.* be round the coast of the United Kingdom, leaving the mainland of Great Britain and Ireland on the port hand; starting from the River Thames and finishing at Dover.

Mr. Samuel Denison and Mr. George Henry Denison, who have been actively engaged in the business of Messrs. Samuel Denison and Son, of Leeds, for several years, were admitted into partnership at the commencement of the present year. The title of the firm remains unaltered.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended January 9, amounted, on 15,386¾ miles, to 1,012,031*l.*, and for the corresponding period of 1886, on 15,246 miles, to 1,011,657*l.*, an increase of 140¾ miles, or 0.9 per cent., and an increase of 374*l.*

A resolution of the Metropolitan Board of Works accepting the design and tender of Sir W. Armstrong, Mitchell, and Co., for two steam ferry boats to convey foot-passengers, cattle, and vehicles across the Thames at Woolwich, the cost of each vessel being 10,650*l.*, has been confirmed.

The steel-constructed unarmoured cruiser Mersey, 12, 3550 tons, 6000 horse-power, which has been fitted at Chatham with the appliances for discharging submarine torpedoes, has received orders to proceed to Portsmouth, where an extended course of trials with the submarine torpedo fittings will be carried out.

The Union Boot and Shoe Machine Company (Limited) is a new undertaking with a capital of 50,000*l.*, which has been formed for the purpose of developing the patents for the United Kingdom of fastening and wire-making and corrugating machines for uniting the soles and uppers of boots and shoes. The invention is an American one.

The sternwheel steel paddle recently brought out to Cape Town by Hawarden Castle, has been transhipped at Algoa Bay to the twin screw coaster Lion, and will be conveyed to the Zambezi. It was sent out by Kincaid and Co., engineers, Greenock, and will draw 16 in. The wheels can be lifted a little by screw gearing in case of need.

We are requested to state that the electric light installation in the Londonderry shirt factory of Messrs. Welch, Margetson, and Co., was erected by Mr. Henry Blake, of Beech Mount, Manchester, and not by Mr. A. W. Richardson, of the Brush Company, as mentioned in our issue of December 17. Mr. Richardson supplied the dynamo.

As a result of the excellent performances of the Belleville boilers on the cargo boat Ortegal, the Compagnie des Messageries Maritimes have ordered from Messrs. J. Belleville and Co., of St. Denis (Seine), two new groups of boilers for the steamboat Sindt, which will have engines of 3000 horse-power. The vessel will be put on the China route.

The electric lighting plant used at the Colonial and Indian Exhibition is to be sold by auction at South Kensington on the 26th and 27th inst. by Messrs. Wheatley Kirk, Price, and Goulty. This firm will also sell on the same days the engines and boilers supplied to the Exhibition by Messrs. Davey, Paxman, and Co. and Messrs. Galloway and Sons.

In the United States a Bill has been passed by 222 votes to 26, creating a Department of Agriculture and Labour, whose chief will be a Cabinet Minister. The new Secretary of Agriculture is empowered to inquire into the causes of discontent between the employers and employed, and may invite and hear sworn statements from both parties in such disputes.

The United States Senate has passed a resolution advising the President to open negotiations with Nicaragua with a view of obtaining a concession for the cutting of an interoceanic canal. This was vigorously opposed in a secret session, but passed after a long debate. A Bill is now pending in the Senate incorporating a company to make the canal.

A telegram from St. Louis states that the leading iron company there, being unable to buy sufficient American pig iron, has contracted for 10,000 tons of No. 3 from the Middlesbrough (England) foundries for immediate shipment *vid* New Orleans. It will be delivered at St. Louis, including duty, at about 21 dols. per ton, this price being 1 dol. below that of American pig iron of similar grades.

The Belgian Minister of Industry and Public Works has issued a circular urging the largest possible participation by the Belgians in the Universal Exhibition at Adelaide in 1887. The circular states that, owing to the participation of Belgium in the Sydney Exhibition of 1879 and the Melbourne Exhibition of 1880, her trade with the Australian colonies, which in 1880 amounted to 10,000,000f., has risen to 60,282,000f. per annum.

A somewhat novel testimony as to the comfort of torpedo boats for cruising purposes, an important point often questioned, has lately come from the Mediterranean. The two sister first-class boats, Falke and Adler, which have been described and illustrated in ENGINEERING, and which were built by Messrs. Yarrow and Co. for the Austrian Government, have both been for some time used for pleasure cruising by the Imperial family.

Another dynamite explosion occurred at the exact spot on the works of the New Ross Railway where the three men were killed on Saturday. The cause of the explosion was the same carelessness in softening the dynamite before using it. A man named Neill placed five cartridges in a tin can which he put upon the fire. Fortunately he then left the place, for only a few minutes afterwards the dynamite exploded, blowing the can and the fireplace to atoms.

A new method of blasting without explosives has been recently introduced by Dr. Kosman, and is described in the eighty-seventh volume of the Institution of Civil Engineers, page 41. Zinc powder and sulphuric acid are contained in a glass cartridge, by breaking which the two substances are brought into contact and hydrogen is rapidly evolved. A pressure of about 37,000 atmospheres is obtained, although, perhaps, with hardly sufficient rapidity to justify the use of the term explosion.

The chief inspectors of machinery attached to the Steam Reserve at Devonport, Chatham, and Portsmouth under the new arrangements will have to vacate their appointments at the end of four years from the time of their taking them up. Subsequent appointments will only be for three years, but as the present chief inspectors accepted their positions with the understanding that they would be as good as had hitherto been the case—for not less than five years—a year's grace has been allowed them.

Instructions have been issued by the Austrian Government to the contractors of a railway to the Russian frontier to complete the line with all speed. The heads of the Austrian railway administrations have been summoned to Vienna, where they received detailed instructions in view of the transport requirements of the army under the contingency of mobilisation. Large contracts for provisions have been made by the War Department, with the stipulation that the deliveries shall be effected in March.

A Cairo telegram to the *Times* states that at the petroleum boring No. 1 at Jemsah the workmen found, at a depth of 365 ft., ozokerite, or solid petroleum—a mineral wax, considered more valuable than petroleum. Now, at 380 ft., they have reached a close-grained coral. Gas and oil are becoming more plentiful. In No. 2 boring at Jemsah slight traces of gas and oil have been found. In No. 3, at a depth of 155 ft., a coral clay has been reached. In the boring at Zeiti, at a depth of 400 ft., hard coral was touched.

Messrs. Robert Boyle and Son, Limited, of 64, Holborn Viaduct, have brought out a modification of their air-pump ventilator, in which they utilise a descending current of the external air to create an up draught or exhaust, the wind passing downwards over the deflecting plates, which are placed horizontally instead of vertically, as in the ordinary form of the air-pump ventilator. The new appliance is intended to be fixed on the roof of buildings which are surrounded by higher buildings. It has been found to answer very well.

Messrs. J. and H. Gwynne, of Hammersmith, have received a contract for erecting two of their "Invincible" centrifugal pumps, each capable of discharging about 62,000 gallons of water per minute, and a supplemental pumping engine of 70 tons per minute. These are for draining the Marozzo Marshes in Italy, which are close to the Ferrara Marshes, where Messrs. J. and H. Gwynne erected some very large pumping machinery some years ago, which was illustrated and described in our issue of July 25, 1873. These centrifugal pumps are to replace some Dutch scoop wheels.

A public meeting was held at the Cannon-street Hotel on Tuesday afternoon, the 18th inst., for the purpose of hearing a detailed explanation of the arrangements in contemplation for obtaining the most beneficial results from the Paris International Exhibition and Congress, or French Railway Jubilee of 1887. The chair was taken by the President of the Institution of Civil Engineers, and the meeting was attended by representatives of railway companies, chambers of commerce, the City Corporation, and other public bodies. A delegation from the French executive committee, accompanied by members of the Municipal Council of Paris and other Paris delegates, came over in order to attend the meeting.

The French December trade returns show a sensible increase in the export of manufactures, a slight decrease in the import of manufactures, a considerable increase in the import of raw materials, and a decrease in the export. Of the imports manufactures were 50,750,000 f. against 51,500,000 f. in 1885; and raw materials, 195,000,000 f. against 174,000,000 f. Of the exports manufactures were, 132,000,000 f. against 127,000,000 f. in 1885; and raw materials, 67,000,000 f. against 71,000,000 f. Taking the whole year 1886 the French imports were 4,234,000,000 f. and the exports 3,300,000,000 f., as compared with 4,088,000,000 f. and 3,088,000,000 f. in 1885. Most of this increase in the volume of trade is due to articles of food.

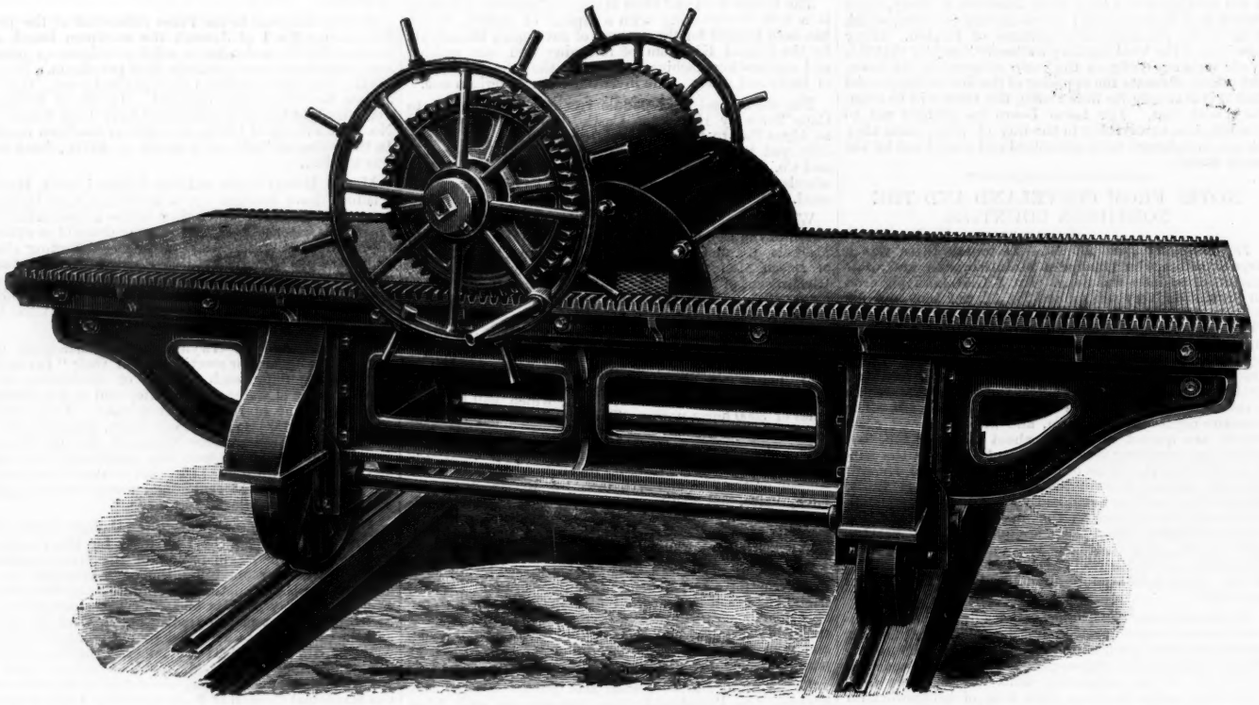
Herr Josef Schulhof, the inventor of the repeating rifle which had been lately tried by the British military authorities, is announced by a Vienna telegram to return to England, having made certain alterations in his rifle, so as to adapt it to the Enfield requirements. The final experiments made with the Schulhof rifle in Vienna proved that the Enfield cartridge could perfectly well be used with it. The alterations, however, reduce the number of cartridges that can be used to load the repeating magazine from ten to seven. Ten cartridges made up the repeating charge of the original rifle for 7½ millimetre cartridges, whereas the Enfield cartridge is one of 9 millimetres. The rifle weighs just 9 lb. One of its great advantages is that the mechanism prevents the cartridge case from sticking in the breech when exploded. The mere action of reloading jerks out the case.

By direction of the late Earl of Iddesleigh thirteen parcels containing samples of tools in common use by Chinese carpenters have been received by the Sheffield Chamber of Commerce for exhibition before the manufacturers and artisans of the town, with a view to stimulate trade with China. The British consul at Swatow, by whom the goods were forwarded, says he has always noticed in the Chinese carpenter's tool-box at least one, if not more, old European plane-irons or chisels, in many instances worn down a third of their original length. This seems to him to indicate a preference for European steel, and that were tools made of such steel, obtainable at anything like the market rate for Chinese tools, a large trade might be the consequence, for the carpenter plays a very important part in Chinese house-building. Fine finish and polish were quite unnecessary, the only requirements being durability and cheapness.

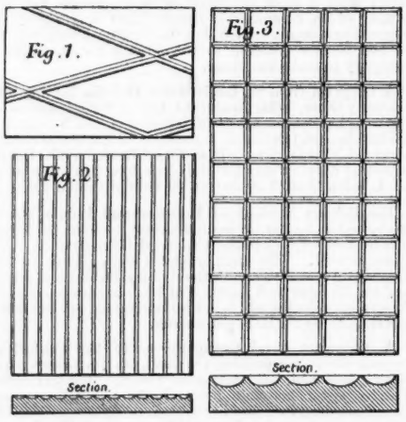
VICTORIAN LOCOMOTIVE BUILDING.—The Phœnix Foundry Company, Ballarat, has supplied to the locomotive department of the Victorian Railways five of fifteen goods engines contracted to be delivered to the department during 1886. The engines are of an exceptionally heavy type, and have been designed to possess a haulage power 15 per cent. greater than that of any locomotives now in use on the Victorian Railways. They have been submitted to severe tests with satisfactory results.

SHEET-GLASS CASTING TABLE.

CONSTRUCTED BY MESSRS. ROBERT DAGLISH AND CO., ENGINEERS, ST. HELENS.



THE sheet-glass casting table, of which we annex a perspective view, is one constructed by Messrs. Robert Daglish and Co., of St. Helens, Lancashire. The pattern to be impressed on the plate is cut on the table; a specimen of diamond pattern glass is shown standing on the table, and various other styles, such as cathedral and fluted glass, are illustrated in the detached views, Figs. 1, 2, and 3 annexed. The molten glass is pressed into the matrix by the passage over it of the heavy roller, which is rotated by hand. The entire machine runs on wheels, so that it can be moved to and from the furnace as required. The general design is very neat and substantial.



NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Last Thursday's warrant market was again strong, and a large amount of business was done, but at irregular prices; the close, however, though under the best price, showed an advance from the previous day's close to the extent of 2d. per ton. Prices started at 47s. 6d. per ton, and got up to 47s. 7½d., the highest rate quoted during the present "boom;" and after falling 5½d., they recovered to the opening quotation, at which the market closed. No change was recorded in the closing quotations for Cleveland warrants, but hematite warrants made an advance of 6d. per ton. A quieter tone prevailed in the warrant market on Friday, and brokers and merchants were evidently taking a little "breathing time," after passing through a fortnight of almost continuous excitement. Prices had rather a drooping tendency, closing near the lowest, and at a decline of 4½d. per ton from the previous day's close, though still leaving an advance of 1s. 4d. per ton on the week, as compared with a gain of 1s. 3½d. per ton over the preceding week. The business done in Monday's warrant market was again large and somewhat irregular, but the close showed no change from last Friday's closing prices. Buyers were rather more cautious than might have been expected from the character of the reports that were in circulation during the day. Cleveland warrant iron improved to the extent of 4½d. per ton, making the difference between it and the price of Scotch warrants 8s. 3d. per ton, while at the opening of the year the difference was as much as 9s. 4½d. per ton. A large amount of business was done in hematite warrants, and prices advanced 1s. per ton, making a gain of 3s. 10d. per ton from the beginning of the year. At the close of last year the price of hematite warrants was 1s. 8d. per ton higher than that of Scotch warrants, whereas the difference at the close on Monday had risen to 2s. 10½d. per ton. Yesterday's market was also characterised by great activity, but, as on Monday, the excitement was chiefly in regard to hematite iron, nearly 30,000 tons of which are said to have changed hands during the day, at prices which showed an advance of from 6d. to 1s. 6d. per ton. Scotch pig-iron warrants at one time showed an advance of 5d. per ton, but that sum was subsequently lost, and the closing quotations were the same as those of Monday. The differences at the close were as follow: Hematite warrants, 4s. 1½d. per ton above the price of Scotch pig, and 12s. 6d. per ton above that of Cleveland warrants. Scotch warrants declined in price this forenoon to the extent of 7½d. per ton, the closing quotations being buyers at 46s. 6d. cash and 46s. 9d. one month, with sellers at 46s. 6½d. and 46s. 10d. respectively. In the afternoon the range was from 46s. 5d. to 46s. 10d. cash, and from 46s. 8½d. to 47s. 1d. one month, the top quotations prevailing at the close. Several of the makers' brands of Scotch iron have advanced very considerably in price, in sympathy with the rise in the price of warrants, Scotch, hematite, and Cleveland; in some cases the rise amounts to 2s. or 2s. 6d. per ton. Last week's shipments of pig iron from all Scotch ports amounted to 9215 tons, as compared with 7557 in the preceding week, and 4725 tons in the corresponding week of last year. They included 2600 tons to the United States, 465 tons to India, 115 tons to Australia, &c., 2290 tons to Italy, 125 tons to China and Japan, and smaller quantities to other countries. There is no change to report in the number of blast furnaces in actual operation, there being still 75 blowing, as against 92 at the same time last year. Only a very small increase is reported in regard to the stocks of Scotch pig iron in the public warrant stores.

The Scotch Steel Trade.—The Scotch steelmakers met in Glasgow this afternoon and resolved to increase their prices by 5s. per ton, so that the rates will now be as follow: Steel angle bars, 6*l.* per ton; ship-plates, 7*l.*; and boiler plates, 7*l.* 5s. Some of the makers were in favour of putting up the price 10s. per ton, which would probably have been agreed to had the hematite pig market not been somewhat quieter. In the event of hematite pig iron making any further material advance in price, it is expected that another increase in the price of steel will soon be announced. A few days ago Mr. Riley, on behalf of the Steel Company of Scotland, informed the steel melters at the Newton and Blochairn works that the directors had agreed to concede an advance of wages by way of anticipation. This resolution has given much satisfaction to the men.

The Coal Trade.—Coalmasters at their meeting in Glasgow to-day were not able to report a satisfactory state of affairs in the coal trade. It seems that a threat recently made on behalf of the Lanarkshire miners that they would enter upon a general strike after to-morrow, in the event of their claim for an advance of wages not being conceded, has done considerable harm to business, as coalmasters and merchants have declined to enter into contracts until they see if the strike is carried out. As a consequence, it is said that ships are going from the Clyde to other ports for coal cargoes. Owing to its scarcity, main coal is 3d. per ton dearer at Glasgow, but other sorts are unchanged in price, the steam coal trade being specially quiet. The minimum shipping rate at Burntisland for Fifeshire steam coal has been advanced in price 3d. per ton, and the miners are now hopeful that their request for an advance of wages will be favourably considered by the coalmasters.

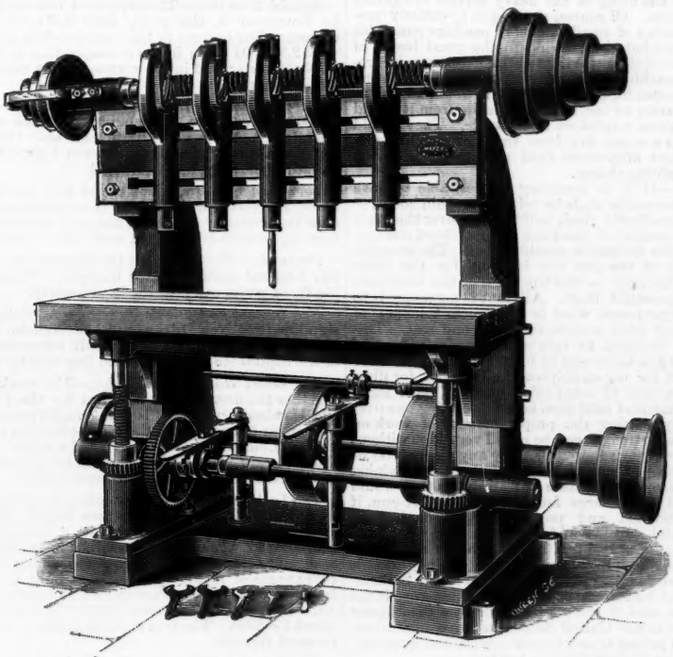
Evening Lectures on Naval Architecture.—Professor Jenkins, the successor of Professor Elgar in the John Elder Chair of Naval Architecture and Marine Engineering in the University of Glasgow, has now fully entered upon the discharge of his duties; and with the view of making his professional work as serviceable as possible to shipbuilders and naval architects, he has announced a course of twelve engineering lectures, the first of which is to be delivered to-morrow night. The subject to which these lectures are to be devoted is "Waves and the Resistance of Ships."

Tramways between Greenock and Port-Glasgow.—At yesterday's meeting of the Greenock Police Board it was agreed to grant permission to the company which has just been projected to lay down a tramway line between Greenock and Port-Glasgow, in consideration of the sum of 1200*l.* to be paid to the Board for the use of the streets. The cost of constructing this line is estimated at 30,000*l.*, the length being rather over three miles. There is at present a 'bus service between the two towns, and it has been calculated that there are no fewer than eighty-six runs of these per day. The thoroughfare at the east end of Greenock is an exceedingly narrow one, and it is expected that the tramway company will have difficulty in coming to a settlement with the feuars whose property they will require for the widening of the street.

Caledon Shipyard, Dundee.—The business hitherto carried on in this well-known shipyard by Mr. W. B. Thompson has been formally transferred to a limited liability company to be known as Messrs. W. B. Thompson and Co. Mr. Thompson, who is to act as managing director, was successful recently in obtaining several contracts, so that the new company starts with a fair amount of work on hand. The Tay Foundry has also been transferred to the new company.

FISH-PLATE DRILLING MACHINE.

CONSTRUCTED BY MESSRS. WILKINSON AND LISTER, ENGINEERS, KEIGHLEY.



THE fish-plate drilling machine illustrated by the annexed engraving has been constructed by Messrs. Wilkinson and Lister, of Bradford-road Iron Works, Keighley, for a French steel works. There are five vertical spindles, four corresponding to the holes in the plate, and the fifth being for a special purpose. Each spindle is driven by a phosphor-bronze wormwheel, which gears with a steel screw running in a lubricating trough the entire length of the frame; the end thrust of the screw is taken by a hardened centre thrust-pin. The spindles can be adjusted to any pitch between 2¾ in. and 9 in. The feeding is effected by the motion of the table, which is raised by vertical screws working in oil boxes. There is a quick return motion. The work to be drilled is immersed in a fixing trough filled with soapsuds, but this is not shown in the illustration. The machine is entirely self-contained.

AMERICAN LOCOMOTIVES.

THE illustrations on the two-page plate represent two locomotives built by the Rogers Locomotive and Machine Works, of Paterson, New Jersey, U.S.A.

The first is a passenger engine for the New York, West Shore, and Buffalo Railroad. It has cylinders 18 in. in diameter by 24 in. stroke, driving four coupled wheels 68 in. in diameter. The total weight of the engine in working order is 97,000 lb., of which 64,500 lb. are carried by the drivers, and 32,500 lb. by the bogie which has a fixed centre bearing. The boiler burns anthracite and carries a pressure of 140 lb. to the square inch. The heating surface is 1204 square feet, of which 1083 ft. are in the tubes and 121 ft. in the firebox. The grate area is 33.3 square feet. The crown sheet of the firebox is supported by transverse girder stays.

The second engine is a ten-wheeled freight locomotive built for the Nashville, Chattanooga, and St. Louis Railroad. This burns bituminous coal and has 1365 square feet of heating surface—1265 ft. in the tubes and 100 ft. in the firebox, the firegrate area being 15 square feet. The cylinders are 18 in. in diameter by 24 in. stroke; the driving wheels, of which there are six, are 55⅝ in. in diameter, and carry 66,300 lb. out of a total weight of 92,970 lb. This boiler, like that of the first engine, is fitted with an extended smokebox and has transverse girder stays to the crown of the firebox; it carries a pressure of 140 lb. to the square inch. The truck is provided with a side swing motion.

EXHIBITION OF TELEPHONIC APPARATUS.—La Société Belge des Ingenieurs et des Industriels have organised an exhibition of telephonic apparatus, which was opened in the salons of the Palais de la Bourse on the 14th inst. It will be accessible to the public on the payment of a trifling fee every day, except Wednesdays, for some time. The principal inventors and manufacturers of the world have contributed apparatus, and it is believed that the exhibition will be the completest of its kind.

SINGLE-NEEDLE SOUNDER.

THE sounder we illustrate below has been devised by Mr. Arthur E. Gilbert, of Inverness, for use on the single-needle instruments of the telegraph system of the Highland Railway, which is under his charge. Fig. 1 shows the dial face with the two gongs in position at either side of the needle. Each sounder

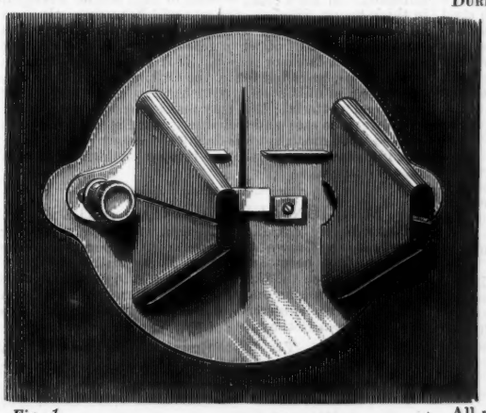


Fig. 1.

Fig. 2.

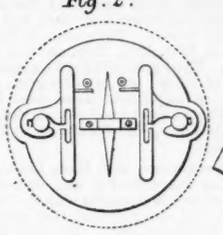


Fig. 3.

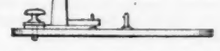


Fig. 4.

is made from a tin blank (Fig. 4), bent as shown and secured by a bolt, a washer being interposed between the dial and the sounder. The needle does not strike on the body of the gong thus formed, but on the end of a tongue bent outwards from it (Fig. 3). This pattern is the outcome of many designs and of no little experiment.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, January 7.

THE production of pig iron throughout the country for 1886 was 1,600,000 tons in excess of the production of 1885. Bessemer steel ingots increased 481,000 tons; Bessemer steel rails increased 550,000 tons; open hearth steel, 67,000 tons. These figures are estimated, but they will be found very little astray when the official figures are known. The total importations of iron and steel for 1886 will foot up not less than 1,000,000 tons. Of these 400,000 were pig iron; 250,000 tons tin-plates, and 125,000 tons wire rods. There were laid last year about 8000 miles of new railroad. This year the new mileage of main track will reach not less than 12,000 miles of main track, and that quantity of rails has already been contracted for. The productive capacity is being increased by the construction of two new mills, and it is possible that one or two more will be projected before summer. The stocks of iron of all kinds are very low. Mills and furnaces are booking orders at a rapid rate. The tendency of prices is strongly upward. No. 1 foundry is selling at 20.50 dols. to 21 dols. Grey forge has advanced from 16 dols. to 18 dols. in twelve months. Bar iron has advanced about 5 dols. per ton; muck bars, 4.50 dols. Ore has advanced slightly, and a further advance is probable should the present strong condition continue a month or two longer. The apprehension in the iron trade is that prices may go still higher, and if they do, disastrous results are anticipated. The steel rail demand is still very heavy, although mills are sold up to midsummer and beyond it. Brokers are receiving urgent inquiries from railroad builders, and from present indications large orders will be placed in British mills within sixty days. The outlook is very bright, and buyers of all kinds of material will certainly make an earnest effort to cover the requirements of the first three months. Iron and steel capacity is being increased for structural and armour plate purposes. Nails are strong at 2 dols. to 2.15 dols. Merchant bar at 1.75 to 2 cents. Wrought-iron pipe is very active, and mills are more crowded with orders for natural gaspipe requirements. Old rails are very scarce. Quotations to-day are 25 dols. to 26 dols. for tees at tide water. Very few have sold above 25.50 dols. Rail blooms are quoted at 29.50 dols. at tide water, and billets at 31 dols. to 31.50 dols., according to size.

STEEL FOR HEAVY GUNS.*

By EDWARD BATES DORSEY, C.E.

DURING the last four years I have been obliged for professional purposes to examine as thoroughly as possible into the suitability of steel for structural purposes. This investigation obliged me to make several trips to Europe, as I was anxious to get the opinion and experience of all the principal steel workers in the world.

The word "steel" as used now, is very comprehensive, embracing material running from a very pure quality of iron, with little or no carbon and a tensile strength of 55,000 lb., up to tool steel with a high percentage of carbon and a tensile strength of over 150,000 lb. In this paper, for convenience, I shall use the terms "mild steel" and "hard steel" with the following meanings:

Mild steel is steel with a very low percentage of carbon, incapable of taking temper; will bend double, when cold, without fracture, and having a tensile strength of from 55,000 lb. to 65,000 lb.

Hard steel is steel with a variable percentage of carbon; will take temper, more or less hard, and having a tensile strength of over 90,000 lb.

Tensile strength, whenever used in this paper, will mean, unless otherwise stated, the ultimate tensile strength per square inch of section in pounds.

All workers in steel will admit the following axioms to be true and indisputable: 1. The treacherous and capricious qualities of steel increase with its tensile strength, being zero about 60,000 lb. tensile strength. 2. The treacherous and capricious qualities of steel increase as the size, thickness, or section of piece increases. 3. The greatest reduction of size, thickness, or section by work within limits will give the greatest increased tensile strength. 4. With the same amount of work within limits the tensile strength decreases as the size, thickness, or section increases.

Mild steel is the most reliable of all cheap metals. It can be badly worked and maltreated with impunity, yet it can be trusted under all circumstances. Hard steel, on the contrary, requires the most delicate manipulation, and even then it will, when in large pieces, break and crack without any apparent cause or reason. In all shops that have worked large-sized pieces of it there are told many stories of how it cracked when it was completely at rest, &c. This has been proved by the recent failures of the steel guns in England, all failing under little or no strain.

Gunmakers are now apparently committing the same errors that civil engineers did when they first commenced to use steel for structural purposes. They found a new, cheap, and strong metal, but their use of high tensile strength steel temporarily brought this material into disrepute. Nearly all failures in its use can be ascribed to this cause.

* Paper read at the United States Naval Institute, Annapolis.

The specifications of the Ordnance Office of the War Department ask for bids for hoops for 8 in. guns, the maximum thickness being $4\frac{9}{16}$ in. (The promised specifications from the Ordnance Office of the Navy Department have not been received.) These specifications call for tensile strength not less than 100,000 lb. per square inch; elongation after rupture not less than 12 per centum in specimens 6 in. in length between shoulders; all to be of open-hearth steel.

Without the oil temper this quality of hard steel would not be used by any bridgebuilder, boilermaker, shipbuilder, or architect where the strain or work is comparatively steady and regular compared to the heavy, sudden shocks caused by the service charge of powder in large guns. As yet, the experiments showing the actual improvement on hard steel by the oil temper in large pieces or masses, are not sufficiently thorough or complete to be conclusive, or to induce the general use of an unreliable material. The advocates of the use of hard steel claim that it is much improved and its nature and character entirely changed by immersion while hot in an oil bath. Unquestionably this has a very beneficial effect upon small pieces. Hard steel is one of the most compact of all known substances. Can the oil of the bath or its good effect penetrate sufficiently far into the interior of this compact material in large masses so as to make a complete change in its character? May not the beneficial effect shown be only on or near the surface—skin deep?

In my judgment, the great improvements reported in the working qualities of hard steel caused by the oil bath on large pieces have not been conclusively demonstrated, especially in face of the recent failures in large steel guns. On the contrary, do not these failures show that hard steel still retains its character unchanged for capriciousness and unreliability? Before spending the millions of dollars for new guns for our Army and Navy, it would be well to test more thoroughly the supposed great improvement made in the character of large masses of hard steel by the immersion in the oil bath. There is no question but that hard steel is entirely too unreliable to be used in its natural state in large pieces for any kind of structural work. These tests and experiments should show conclusively that the oil temper changes a structural material, unsafe for the most simple work, into material reliable for the most trying and difficult service. If these experiments do not show this beyond question, then hard steel should not be used for the large guns.

The Lloyd's Register of England have probably more practical knowledge of steel than any person, firm, or corporation. Mr. Parker, their chief engineer, who has been a most indefatigable experimenter and investigator in steel, was among the first to advise its use in marine architecture, especially for boilers. Notwithstanding their long experience, the following order was issued last month: "The committee of Lloyd's Registry for British and foreign shipping, having been advised by their technical engineering staff that it was fitting that there should be greater stringency as to the tests to which steel for boilers is subjected, have issued modified instructions on the subject. Formerly all steel for boiler plates was required to have an ultimate strength of not less than 26 (long) tons nor more than 30 tons per square inch of section, with an ultimate elongation of not less than 20 per cent. in a length of 8 in. In the matter of elongation their requirements remain the same, but as regards the breaking strain a sliding scale is adopted as follows: The material of stays and of plates not exceeding 1 in. in thickness is to have an ultimate tensile strength of not less than 26 and not more than 30 tons per square inch of section; in plates above 1 in. and not more than $1\frac{8}{8}$ in. in thickness, the ultimate strength must not be less than 26 and not more than 29 tons per square inch, and in plates above $1\frac{8}{8}$ in. in thickness, not less than 26 tons and not more than 28 tons per square inch." Here we have the most experienced body in the world reducing the tensile strength proportionally as the thickness increases, in order to get good, reliable metal for boilers. We, however, increased largely the tensile strength with the thickness in our gun-metal. These two practices are very different; which is right?

The preceding statement, analysed, shows thus:

Plates and stays 0 to 1 in. thick, maximum tensile strength 67,200 lb.

Plates and stays 1 in. to $1\frac{8}{8}$ in. thick, maximum tensile strength 64,960 lb.

Plates and stays over $1\frac{8}{8}$ in. thick, maximum tensile strength 62,720 lb.

If the same proportion should be extended to a plate 3 in. thick, the maximum tensile strength would be 55,052 lb.

As it is impossible to work exactly to the minimum and maximum limits, practically the specifications for guns are double what is considered safe for boilers.

The Duke of Cambridge, Commander-in-Chief of the British Army, said in the House of Lords on April 30, 1876: "Out of seventy heavy guns employed against the south-west of Paris (by the Germans) thirty-six were disabled during the first fortnight of the bombardment by the effect of their own fire." This is strong language from very high authority, and shows that even Krupp's guns may fail when tested by actual service. The preceding also shows the great necessity of investigation before adopting for our guns the treacherous hard steel.

All who have worked large pieces of hard steel have noticed that serious cracks and fractures originate in very slight cuts, nicks or punctures in the metal; in fact, on this class of metal all such injuries are carefully avoided, and when they unavoidably occur are, if possible, carefully cut out. In working hard steel, in order to prevent the starting of these cracks, no holes are punched unless carefully reamed out afterwards, and no edges cut or sheared unless afterwards planed. Mild steel is not affected in this manner.

In battle these large guns must receive many dents or cuts from shot from small cannons and machine guns. These injuries may not be sufficiently large to cause direct weakness of the gun, but they are ample to originate the fatal cracks so common and unaccountable in hard steel. The formation of these cracks will be accelerated by the firing of the heavy service or fighting charge of the gun. Of course, if the gun is entirely protected from the fire of small cannon or machine guns, this risk will be avoided; but, owing to the great length of modern guns, it is doubtful if its entire length can be protected from machine gun fire. Before finally adopting this class of metal for our large guns, it would be well to make experiments, to see how guns made from it would act under the same conditions as in battle. They should be subjected to a severe fire from small cannon and machine guns, and afterwards fired repeatedly with the usual severe fighting charge.

Conclusions.—If it is necessary or desirable to have light guns, these can be made by using many thin hoops, or cylinders, made of mild steel, building one over the other on the barrel, instead of the thick hoop of hard steel, as called for in the Ordnance specifications. The strength and reliability of the gun will increase for the same weight proportionally as the thickness of the hoops decreases to a practical limit. All that is necessary is to find out by experiment what is the proper thickness of hoops consistent with weight, strength, and cost. This thickness may be found to vary with the size and use of the gun. The gun to be used in fortifications need not be so light as that for use on shipboard. Suppose, for illustration, that instead of using thick hoops of hard steel, twelve hoops made of mild steel be used, placing one over the other. By putting the proper amount of work on these, the tensile strength can be raised very high without impairing the quality; moreover, if by any chance one or two of these hoops should break or fail, the remaining ones will be ample to sustain the strain, as they would always be used with a large factor of safety. A gun, if properly constructed and proportioned, made in this manner of mild steel, could not fail, even with any reasonable amount of bad treatment. This is a practical application of the old adages: "In union there is strength;" and "Not to put all your eggs in one basket."

The steel that I advise to be used for making guns is the ordinary mild steel of commerce, made by a great many establishments in the United States in large quantities, and which can be had at any time in any desired quantity. It is now selling at about 60 dols. per ton.

The hard steel called for in the specifications is a special product, not used to any extent in commerce, being too unreliable and expensive for any commercial use. It must be manufactured to order, and owing to this and to the severe specifications, the cost will be great.

By the use of many and thin hoops, or cylinders, of mild steel, properly built up and proportioned, a gun can be made that will be at all times safe, reliable, and unfailing. If hard steel, or steel of high tensile strength, in thick hoops, is used, the gun will be more costly, and of greater theoretical strength, but practically much weaker, and will fail when least expected, and without any apparent cause or reason. If it is necessary to have thick hoops, as called for in the Ordnance specifications, make them of mild steel, giving the necessary strength by additional material; this may make a heavier gun, but it will always be safe and reliable. Hard steel should not be used until much more is definitely known of the supposed improvement of the oil temper on large pieces or masses of metal.

FOREIGN AND COLONIAL NOTES.

Water Supply of Sydney.—Nepean water is now flowing direct into the Crown-street reservoir. A permanent line of pipes has been laid from Potts Hill to Crown-street, and when the pipes have been subjected to a little cleansing or washing out, the water will run through them into the reservoir, instead of being pumped into it, as is now done from Botany.

Port Jackson.—Two 13½-ton guns of the latest pattern have arrived at Sydney. They are to be used in strengthening the harbour batteries of Port Jackson.

New French Cruisers.—In accordance with a decision of the French Minister of Marine two first-class cruisers are about to be put on the stocks, one at Brest and the other at Rochefort. These ships will be built of steel, and will be furnished with barbette towers. They are to be 353 ft. 4 in. long, 43 ft. 7 in. wide, 18 ft. 10 in. deep, and they will measure 4160 tons each. Their armament is to consist of four guns of 6.3 in., six of 5.5 in., ten revolver guns, and four tubes for throwing out torpedoes. Their speed is to be 19 knots per hour. The cruiser to be built at Brest is to be called the Dupuy-de-Lôme, and the one to be built at Rochefort the Jean-Bart.

The Garonne.—French engineers, with M. de Lesseps at their head, are advocating the widening and deepening the Garonne to a point where it connects with the Canal du Midi, near Toulouse, and the enlarging that canal to its termination on the Mediterranean. The idea is to afford water communication for vessels of the largest size between the Mediterranean and the Atlantic. Bordeaux would then be made accessible at all times to steamers of the largest class. The present long Spanish detour would be avoided, and ships could sail from New York direct to Marseilles, Genoa, and all ports of Northern Italy.

Hell Gate.—The Hell Gate electric light is to be discontinued as being dangerous to navigation. Pilots state that while they can see well inside the circle covered by the light they are unable to see beyond it.

German Coal Exports.—The exports of coal from the Zollverein, in July, amounted to 670,107 tons, as compared with 688,821 tons in July, 1885. The aggregate exports in the first seven months of last year were 4,767,307 tons, as compared with 4,928,911 tons in the corresponding period of 1885. Of the 4,767,307 tons of coal exported from Germany to July 31 last year, 1,594,886 tons went to the Low Countries, 1,377,750 tons to Austria and Hungary, and 582,231 tons to France.

Spanish Iron Ore.—The exports of iron ore from Bilbao to November 6, this year, were 2,674,950 tons. The corresponding exports in the corresponding period of 1885 were 2,908,594 tons; in the corresponding period of 1884, 2,703,695 tons; and in the corresponding period of 1883, 2,895,120 tons.

More Steamers for the Great Lakes.—Two iron steamers of 2300 tons each are to be built for service on the Great American Lakes for the Baltimore and Ohio Railroad Company. They are to ply between Fairport, Ohio, and Dulath, Sandusky, and Cleveland.

Louisiana Iron Ore.—Iron ore of fair quality has been found in Northern Louisiana in considerable quantities near the surface. The fact has not received much attention, as there is not much coal in the vicinity.

Pensacola.—Pensacola has the deepest natural outlet of any harbour south of Cape Hatteras. Vessels drawing 24½ ft. of water can pass the bar in safety.

New Orleans and Rio de Janeiro.—A projected steamship line from New Orleans to Rio de Janeiro is assuming distinct shape. If New Orleans will subscribe one-fourth of the capital stock the proposed line will be organised.

The Great Hawkesbury Bridge.—The work of putting together the first caisson intended for the foundation of the Hawkesbury Bridge is being rapidly proceeded with at Danger Island, where the representatives of the Union Bridge Company have constructed a wharf and erected the necessary plant. The material for the second caisson is expected shortly from the United States.

The Lachine Bridge.—The stonework on the new Canadian Pacific Railway bridge over the St. Lawrence at Lachine was finished November 12, a fortnight ahead of the contract time. Work was begun on May 12, 1886, and since then twelve piers, containing about 10,000 cubic yards of masonry, have been built in water from 18 ft. to 25 ft. deep, with a current in many places of 7½ miles an hour. The contract price for the stonework is about 150,000*l.* The iron superstructure is to be pushed forward rapidly.

The French in China.—A French syndicate, represented in China by M. Thevenet, has obtained a contract for works involving an outlay of 345,000*l.* The syndicate, formed under the patronage of the Comptoir d'Escompte, comprises the Fives-Lille Company, the Forges et Chantiers de la Méditerranée, the Cail Company, the Ateliers et Chantiers de la Loire, &c.

Brazilian Guarantees.—The policy of the present Brazilian Government in regard to railways is to grant no more guaranteed lines to be constructed by foreign companies, and to lease, if not to sell, all the Government railroads, the view being that administration by the State works badly and serves chiefly to furnish places for excessive swarms of second-rate engineers and idle employés, foisted into employment by political influence. The guaranteed concessions of thirteen central sugar factories have been cancelled, and the guarantee on seven others has been suspended.

Intercolonial Railway.—The Canadian Government has purchased six miles of railway running from Westville to Stellarton, and owned by the Acadia Coal Company, for 10,000*l.* The line thus purchased will form part of a branch connection of the Intercolonial Railway with Pictou.

Lighthouses as Signal Stations.—The question of utilising lighthouses and light vessels as signal stations in telegraphic communication with each other, and connected with a central station for reporting arrivals, departures, casualties, and meteorological observations, has for some time received the consideration of lighthouse authorities generally; and Canada has now a large proportion of its lighthouses so arranged.

A Cheap American Lighthouse.—The Keystone Bridge Company has received a contract from the city of Chicago for the construction of an iron lighthouse on the north shore inlet crib for 500*l.* The structure will be of iron, will rise 60 ft. above the water level, and will be lighted by electricity.

Heavy Engines for the Northern Pacific.—One of some large engines ordered for the western division of the Northern Pacific Railroad has arrived out. The cylinders are 22 in. in diameter, and have 26 in. stroke. When in working order the engine weighs 80 tons.

A Queensland Bridge.—The Queensland Minister for Works has recommended the acceptance of a tender of Messrs. J. W. Sutton and Co., for the ironwork of the Albert River railway bridge, at 4322*l.*, which the colonial chief engineer states is only 5 per cent. over the cost of the English material landed in the colony.

Water Supply of New York.—The New York Aqueduct Commissioners now call for 1,400,000*l.*, instead of 1,000,000*l.*, for the ensuing year's expenditure.

Mexican Railway.—Mr. A. M. Rendel, consulting engineer of the Mexican Railway Company, Limited, reports: "The line has been maintained during the past half-year in good order. Strict attention has been paid to drainage with a view to the periodical rains. Many minor improvements have also been carried out. In the Cumbres three miles have been relaid with 82 lb. rails, making a total of 7¾ miles laid on this section with heavy rails. The total length of line now laid with steel rails is 265 miles. The line laid with steel sleepers continues in very satisfactory order."

"ENGINEERING" ILLUSTRATED PATENT RECORD.

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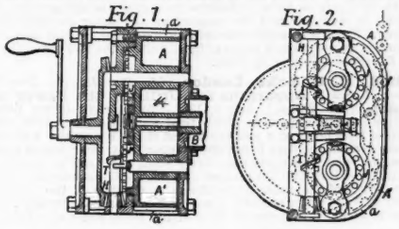
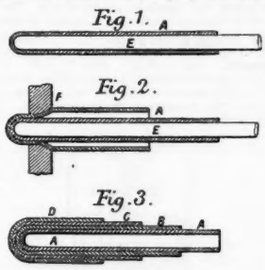
FIREARMS.

9859. C. W. Worrell and F. Podger, London. Improvement in Machine Guns. [8*d.* 6 *Figs.*] August 19, 1885.—This invention has for its object to avoid the jamming of cartridges by making the firing chamber or cartridge bed of machine guns of two or more pieces. The axis of the gun barrel B is situated in the line of contact of two circular blocks A, A^1, which have on their circumference a number of semi-cylindrical grooves *a* at equal distances apart like the teeth of wheels, but placed so that when the circular blocks are turned with the same circumferential speed, any groove of one block in passing the line of contact will come exactly opposite a corresponding groove of the other block, and form with the same a cylindrical bore or cartridge bed. The depth of each block is about equal to the length of a cartridge. One of the two blocks may carry a belt of cartridges. When the charge is exploded, the strain is taken up by the heavy



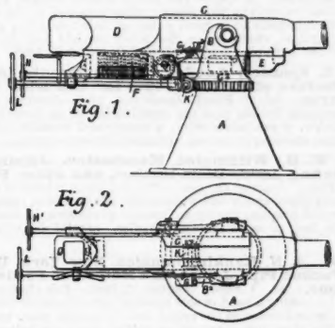
circular cartridge blocks or discs A, A^1, and the danger of bursting the case is avoided. As the blocks are turned, and the cartridge belt drawn in, each cartridge lies in its consecutive semi-circular groove until it approaches the line of contact; and as the cartridge is only fully inclosed at one point—at which it is fired—and then only for an instant, the risk of its being jammed is reduced to a minimum. As soon as each cartridge is fired, the cartridge bed or chamber opens by the rotation of the blocks, the clearance becoming greater until the empty case drops out. The two cartridge blocks A, A^1 are caused to rotate in opposite directions by a shaft H carrying two worms I, I^1 which engage with pins J, J^1 formed on each of the blocks A, A^1. A portion of each worm is at right angles to the axis of the shaft for the purpose of locking the blocks A, A^1, whilst the striking gear is firing the cartridge held in it. (*Sealed October* 19, 1886).

10,315. H. H. Lake, London. (*W. H. Brown, New York, U.S.A.*) **Manufacture of Ordnance and Gun Barrels.** [8*d.* 3 *Figs.*] August 31, 1885.—The cylindrical shells A, B, C, D, which are combined to form the gun, are first made by subjecting heated sheet or plate metal to the operations of folding in and drawing by means of suitable dies and mandrels. Each shell is made of considerably larger diameter than the one which it is to receive. In combining the shells, the innermost and smallest shell A is placed on a mandrel E, Fig. 1, and the mandrel and



shell having been introduced into the next larger outer shell B, they are forced together through a suitable die F of such a size that by the passage of the shells through the die, the outer shell B is folded down tightly on to the exterior of the shell A, Fig. 2. This operation is repeated with each shell in a cold state until the shells are all contracted solidly one upon another (Fig. 3). The mandrel is then removed and the gun completed. The shells may have in their closed ends a small hole serving to facilitate the withdrawal of the mandrel. (*Sealed August* 17, 1886).

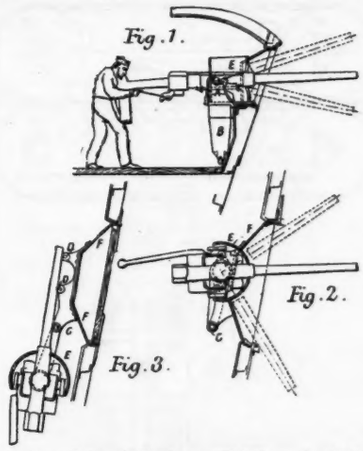
11,173. T. Nordenfelt, London. Improvements in Gun Carriages, Applicable Especially to Machine Guns. [8*d.* 2 *Figs.*] September 19, 1885.—The gun D is able to slide longitudinally in a cradle C which is supported by trunnions resting in bearings formed in the forked standard B which is carried by a conical pedestal A. E is a ram fixed to the gun, and entering a cylinder C^2 formed in the cradle. This cylinder communicates with another cylinder C^3 of larger diameter, which also contains a ram abutting upon a spring F formed by a series of dished discs of steel. When the gun is fired, the ram E is driven into the cylinder C^3, whence liquid is forced into the larger cylinder C^3, thus causing the ram of this cylinder to compress the spring F. When the recoil is complete, the reaction of the spring brings the gun forward again to the firing position. A third cylinder G mounted upon the cradle and in constant communication with the other cylinders, has a ram which abuts upon an arc B^2 on the standard B. While the gun is in movement during the recoil and the return to the firing position, the ram of the cylinder G is exposed to pressure, and the brake block which it carries bears forcibly against the arc B^2, thus locking the gun so that the elevation cannot be changed, and the gun has not to be separately aimed for each discharge. The elevation may be changed by



means of elevating gear consisting of an axis on which is a hand-wheel H and a worm. The gun may be trained by means of a handwheel L which operates a worm K^1 that engages with teeth formed round the pedestal A. (*Sealed November* 23, 1886).

12,202. J. Whitley, Leeds. Improvements in the Construction of Bronze Guns and other Ordnance. [6*d.* 2 *Figs.*] September 25, 1886.—The improvements relate chiefly to the contraction of strengthening hoops or discs upon the barrel portion under the influence of a refrigerating medium. (*Accepted November* 9, 1886).

12,729. R. T. Brankston, Elswick, Newcastle-on-Tyne. An Improved Mounting for a Quick-Firing Gun. [8*d.* 4 *Figs.*] October 23, 1885.—This invention has for its object a mounting for a quick-firing gun which will admit of the gun, when not in use, being housed or turned to one side away from the embrasure, and so lie close against the side of the ship or battery (Fig. 3) The trunnions of the gun or gun slide are carried in bearings upon a fork-like piece or casting A having a descending vertical stem or pivot which is received into a socket B on the



outer or free end of a gate-like frame. This frame is pivotted at C to an armour plate shield F, in which is an embrasure through which the gun projects when in position for firing (Figs. 1 and 2). The embrasure is then partly closed by a semi-cylindrical shield E fixed to the piece carrying the trunnions. This shield is concentric with the pivot of the gun, and moves with the gun when the latter is trained upon the object aimed at. The vertical movement of the gun in elevation, however, takes place independently of the shield. D are bolts for locking the gun in fighting position. (*Sealed November* 5, 1886).

112. H. A. Schlund, Aston, Warwick. Improvements in Percussion Fuzes. [8*d.* 4 *Figs.*] January 4, 1886.—The improvements consist in providing the fuze with a striker formed with a conical pin, which is held by a soft metal ring until the projectile is discharged, whereupon the conical pin opens or enlarges the hole in the ring, so as to liberate the striker. (*Sealed January* 11, 1887).

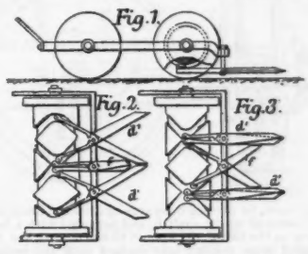
395. O. Jones, London. Improvements in Magazine or Repeating Rifles and other Firearms. [1*s.* 1*d.* 18 *Figs.*] January 9, 1886.—This invention relates to various improvements on a former patent of the same inventor for firearms in which the operations of loading, cocking, and extracting are performed by the to-and-fro movement of a sliding piece arranged behind the barrel in such a manner that, in using the gun, the sliding piece is operated by the hand nearest the shoulder, without any lateral, rotary, or angular movement. The breech mechanism is combined with the guide-bar and lock-plate in such a manner that they constitute a separate and distinct device which can be readily inserted into, and removed from, the gun. A magazine is fitted to slide up and down in guides at one side of the gun, in combination with mechanism for successively transferring the cartridges from the magazine into the gun. (*Accepted November* 9, 1886).

4944. J. A. Scotcher, Bury St. Edmunds, Suffolk, and G. E. Bond, Thetford, Norfolk. Improvements in the Method of Loading Cartridges. [4*d.*] April 9, 1886.—The improvement consists in using a loose composition in powder or granulated form in the place of, or in conjunction with, the wadding. (*Accepted December* 10, 1886).

10,611. J. A. C. de Latouche, Paris. Apparatus for the Concentrated Fire of Ordnance. [11*d.* 12 *Figs.*] August 19, 1886.—This invention relates to an angle-measuring apparatus by means of which several pieces of ordnance situated on the same ship may be inclined and set in such a way that the trajectories of their projectiles shall have as a mark, at a given moment, a common predetermined point. (*Sealed January* 4, 1887).

AGRICULTURAL MACHINERY.

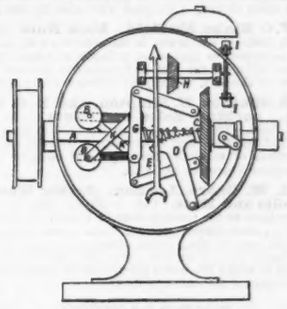
13,812. E. H. Marcuse, Berlin. Improvements in Hand Mowing Machines. [8*d.* 3 *Figs.*] November 12, 1885.—This improved hand mowing machine is based on the principle of the well-known garden shears. The shears are operated by means of a roller provided with suitable cam grooves, in which work friction rollers attached to the rear arms of the shears. d^3, d^3, are the cutting blades of the main shears; *f* is a pair of subsidiary



shears for cutting the stalks left standing by the main shears. Fig. 2 is a plan view of the underside of the forward half, with the two main shears open and the subsidiary shears closed. Fig. 3 is a like view, with the main shears closed and the subsidiary shears open. As the machine is pushed forward, the rotary movement of the cam roller causes the shears to open and close so as to sever the stalks of the wheat or barley. (*Sealed October* 29, 1886).

INDICATING APPARATUS.

10,472. J. Pearce, Glasgow. Speed Indicator with Alarm Attachment. [8*d.* 3 *Figs.*] September 4, 1885.—On the spindle A are placed two balls B, B, which are kept on the side of the spindle by a coiled spring, but when the spindle revolves, the centrifugal force overcomes the spring, and causes the balls to fly out. Straps K are fixed to the centres of the balls B, and are crossed, so that when the balls rise, they will be drawn towards the centre and so take the leverage off the coiled spring.



As the balls B, B, fly out, they draw an arm G forward which is connected by the rack D to a pinion wheel on the pointer E. The pointer E will thus indicate the number of revolutions on the dial. The arm G also draws forward the cone C which revolves with the spindle A till the speed is so high that the cone is drawn so far forward that it comes in contact with the cone H, which is connected to the swing hammers I. These swing hammers are thus caused to revolve and strike the gong J, and so sound the alarm. (*Sealed September* 14, 1886).

TRANSMITTING POWER.

14,293. F. H. Keane and D. Wilson, Cappoquin, Waterford, Ireland. Belt and Strap Fasteners. [8*d.* 4 *Figs.*] November 21, 1885.—The improved belt fasteners consist of two lever-grips, in which a serrated jaw and a prolonged tail are at right angles to each other, the lever-grips being free to move upon the bars of an embracing link, and the grip of the jaws being effected by the pressure of the extended strap, when in work, upon the tails of the lever-grips. (*Sealed November* 26, 1886).

15,671. T. H. Smethurst, Oldham, Lancaster. Connecting or Fastening the Ends of Driving Bands or Belts. [8*d.* 7 *Figs.*] December 21, 1885.—The ends of the belts are bent up at right angles to the plane of the belt and are clamped between two spiked plates which are drawn tightly together by means of screw bolts. (*Sealed December* 24, 1886).

781. R. Macer, London. A Method of Fixing on Shafts Divided Pulleys, Wheels, or Bosses. [6*d.* 1 *Fig.*] January 18, 1886.—The divided pulleys are fixed on shafts by causing to engage with each other the dovetails of the equal and symmetrical halves. (*Accepted November* 16, 1886).

4612. F. G. Hands, A. C. Hands, and W. Thomas. Adjustable Brackets for Carrying Shaft Bearings. [8*d.* 6 *Figs.*] April 2, 1886.—The improved adjustable bracket comprises a base bracket, a "swivel bracket" resting upon the face of the base bracket and capable of movement in slots formed in the base bracket, and a bearing provided with a flange connected by bolts in circular slotted holes with the "swivel bracket." (*Accepted November* 12, 1886).

12,987. P. M. Justice, London. (*W. H. Dodge, Wishawaka, Indiana, U.S.A.*) **Improvements in Wooden Pulleys.** [8*d.* 17 *Figs.*] October 12, 1886.—The process of making wooden pulleys from segments consists essentially in joining the segments at their ends to constitute individual rings so that, in the final assembling of the parts, these rings may be handled as entireties and glued together without the use of nails. (*Accepted November* 12, 1886).

12,988. P. M. Justice, London. (*W. H. Dodge, Wishawaka, Indiana, U.S.A.*) **Improvements in Pulleys.** [8*d.* 14 *Figs.*] October 12, 1886.—The improvements relate to the manufacture of a pulley having a wooden rim and a metallic centre and arms, the ends of which are provided with ribs expanded at their outer ends and embedded and rigidly fastened in corresponding notches cut in the inner periphery of the rim. (*Accepted November* 12, 1886).

8617. O. F. Jonsson, Stockholm. Friction Couplings. [6*d.* 2 *Figs.*] July 1, 1886.—The object of this invention is a friction coupling for rapidly revolving engine shafts, particularly

for the coupling of dynamo machines. A is the driving shaft, and B the shaft which is to be coupled with the former. The improved friction coupling consists of a centre piece F secured on the shaft A, and provided with slots in which brake blocks G connected with a box P movable on the shaft when required to couple by the agency of pivotted link bars L, M, may, by means of the

Fig. 1.

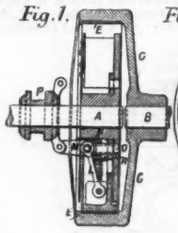
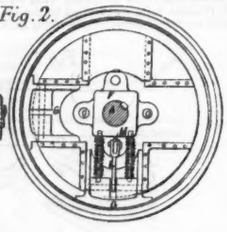


Fig. 2.



centrifugal force, be pressed outwards against the inner border of a pulley C secured on the shaft B, and provided with a leathering E. As long as the two shafts are not to be coupled, the blocks G are prevented from coming into contact with the pulley C by means of a shoulder R on the tail N of the link bar M, the tail being stopped by the edge of the hole O. (*Sealed October* 15, 1886).

LOCKING NUTS, &c.

100. H. J. Allison, London. (*G. Haseltine, New York, U.S.A.*) **Nut Fasteners.** [8*d.* 5 *Figs.*] January 4, 1886.—The improved nut fastener consists of two connected plates, the outer plate having a spring-lip extending tangentially to a circle whose diameter is equal to the small diameter of the nut, and the rear plate being entirely removed from the lip, and re-enforcing the body of the plate. (*Sealed December* 21, 1886).

806. J. Trippett and T. Searls, Sheffield. Lock Nuts and Appliances Connected therewith. [8*d.* 9 *Figs.*] January 19, 1886.—This invention relates to an improved method of locking nuts by the employment of nuts with indentations or teeth on their faces in combination with a washer of lead or other ductile material interposed between the indented face of the nut and the indented or projecting or indented boss on a fishplate or other object. (*Accepted November* 19, 1886).

1141. F. C. Blake, Sheffield. Lock Nuts. [8*d.* 6 *Figs.*] January 26, 1886.—A slot is cut in the side of a nut, and the base of the nut is formed so that when it is screwed down to its place the pressure will close the slot and cause the threads of the nut to grip those of the bolt. (*Accepted November* 26, 1886).

1640. R. Simpson, H. Simpson, and B. G. Simpson, Sheffield. Locking Bolts and Nuts. [8*d.* 3 *Figs.*] February 4, 1886.—The top portion of the hole in the nut is made conical or bell-mouthed, and either with or without screw threads, for the purpose of receiving the expanded ends of a split end bolt. (*Accepted November* 19, 1886).

6796. J. W. Grove, London. Spring Washers for Screw Bolts and Nuts. [8*d.* 8 *Figs.*] May 20, 1886.—This invention relates to the manufacture of blanks for helical spring washers of a girder-shaped section, from a bar having a deeper groove on the one side than on the other, so that on coiling the bar with the deeper groove on the outer side, the extension of the metal tends to make the outer groove about equal to the inner groove. (*Accepted December* 10, 1886).

ENGINE PACKINGS.

15,698. A. A. Ricaby, Sunderland, Durham. Improvements in Packing for Piston Rods. [8*d.* 5 *Figs.*] December 21, 1885.—Inventor claims the application of metallic packing rings inclosed in a cylindrical case with which they are free to move laterally within the cavity of the stuffing-box, the gland acting on their inclined backs with the inside of the case as a fulcrum to keep the inner rings in adjustable contact with the rod, the surfaces of these rings next the rod being preferably perforated to facilitate lubrication. (*Sealed December* 28, 1886).

29. W. Filshie, Grangemouth, Stirling, N.B. Metallic Packing for Pistons. [8*d.* 5 *Figs.*] January 1, 1886.—The improvement consists in the use of an L or wedge-shaped ring fitted to the junk ring, and pressed against this ring and the packing ring by a wave spring. (*Sealed January* 7, 1887).

158. J. Colong, Blackburn, Lancaster. Metallic Packing for Pistons and Stuffing-Boxes. [8*d.* 4 *Figs.*] January 5, 1886.—The packing for pistons consists of an inner and outer ring placed on each other, provided with helical or rectangular slits, and employed on the piston head, so that the outer ring is in intimate contact with the interior of the cylinder. (*Sealed January* 11, 1887).

2697. H. Jack, Glasgow. Improvement in Piston Packing. [8*d.* 10 *Figs.*] February 24, 1886.—The improvement consists of an elastic ring or segments acted upon by spiral springs, so that by pressing against the internal V-shaped surface of the packing rings, these rings are forced simultaneously outwards against the cylinder and against the flanges of the piston. (*Accepted November* 16, 1886).

13,443. G. G. M. Hardingham, London. (*R. N. Pratt, Hartford, Conn., U.S.A.*) **Manufacture of Asbestos and other Packings.** [8*d.* 5 *Figs.*] October 21, 1886.—The improvement consists in immersing a rope or cord of asbestos or other fibrous material in a solution of india-rubber and naphtha or sulphur, then removing the rope and wiping off the surplus solution. (*Accepted November* 23, 1886).

PIPE JOINTS, &c.

14,227. P. Hoppe, Berlin. Improvements in Joints for Pipes, Tubes, or the like. [8*d.* 4 *Figs.*] November 20, 1885.—In order to enable small bends in flange-jointed piping without prejudicing the tightness of the joint, one part of the joint forming the end of one pipe is, according to the present invention, made externally in the form of a segment of a sphere, and is attached to a flange on the adjacent pipe by means of a loose flange in the form of a ring and by screw bolts or studs. (*Sealed November* 26, 1886).

14,389. H. Ainsworth, Great Harwood, R. Hindle, Blackburn, G. Haworth and J. Ainsworth, Preston, Lancaster. Improvements in Hose Piping and in Machinery or Apparatus for Producing the Same. [8*d.* 2 *Figs.*] November 24, 1885.—The improved hose piping consists of an inner and outer tube, woven one within the other. A shuttle box having a backward and forward movement is employed in the looms for weaving the hose piping, in order to obviate the intertwining of the weft threads, and allow the reed to beat up an even weft all round each of the tubes so as to give them a uniform strength throughout the entire round. (*Sealed December* 10, 1886).

15,860. H. L. Doulton, London. Improvements Relating to the Joints of Stoneware Pipes. [8*d.* 2 *Figs.*] December 24, 1885.—The improvements consist in providing near the ends of the pipes a collar moulded in the stoneware, which is made to support a ring of gasket or other pliable material against which, when the pipes are laid together, the socket of the next pipe abuts. (*Sealed December* 31, 1886).

97. A. Spencer, London. Improvements in the Manufacture of Flexible Pipes for Use with High Pressures. [8*d.* 6 *Figs.*] January 4, 1886.—Inventor claims in a compound flexible pipe the combination of an inner pipe of india-rubber, a canvas covering, a superposed metallic coil, and an external covering of canvas (*Sealed January* 4, 1887).

467. W. H. Withington, Manchester. Joining or Connecting Lead, India-Rubber, and other Pipes. [8*d.* 2 *Figs.*] January 12, 1886.—This invention relates to means for joining pipes readily and without the use of solder, consisting of a screwed coupling having an internal projection in combination with two or more screwed ferrules. (*Sealed December* 17, 1886).

10,700. A. N. Rankin, Jamaica, New York, U.S.A. Cold Packed Pipe Joints, and Method of Producing the Same. [8*d.* 9 *Figs.*] August 21, 1886.—The pipe joint is formed by casting a band of soft metal of equal diameter throughout its circumference on the spigot end of a metal pipe, then inserting the pipe into a companion section having a bell-mouth, and finally upsetting the packing band so as to make it adapt itself to the walls of the pipe. (*Sealed December* 28, 1886).

MISCELLANEOUS.

11,063. J. Lang, Wakefield, Yorks. Rope Hauling Apparatus for Towing, Lifting, and such like Purposes. [8*d.* 2 *Figs.*] September 17, 1885.—When a rope is hauled by passing it round drums or pulleys, the flexure tends to strain and wear the rope, particularly when it is a wire rope of considerable diameter. According to this invention the rope is grasped without flexure, and can be readily engaged with or disengaged from the hauling apparatus. Fig. 1 is a side view, and Fig. 2 is a transverse section of apparatus adapted for hauling a rope R. On a fixed lower framing A are mounted two chain wheels B and several guide rollers C. An upper framing D jointed to A at E, has also mounted in it two chain wheels B¹ and guide rollers C¹. By means of a lever arm F worked by a screw or otherwise, the whole of the upper frame D with its chain

Fig. 1.

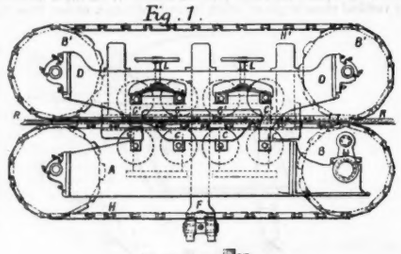
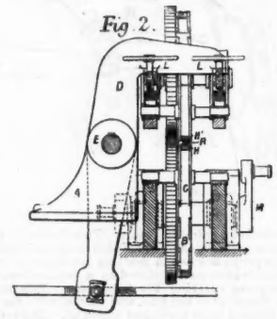


Fig. 2.



wheels and guide rollers can be caused to turn up on the joint E, or can be turned down to the position shown in Fig. 2. Round the wheels B, and the upper wheels B¹, pass endless chains H, H¹, each consisting of straight links grooved along their external faces to receive the rope R which is firmly clamped between the two chains that are pressed together by the guide rollers C, C¹; the several sets of rollers having their bearings pressed on by springs with a pressure that can be regulated by screws L. An engine acting on a crank M, drives the wheel B directly, and drives by gearing the upper wheel B¹, and thus the two chains H, H¹, are caused to move together, hauling the rope, or hauling on the rope R that is clamped between them. For the purpose of disengaging or engaging the rope R, the upper frame is raised, leaving between the two chains a clear space for the removal or insertion of the rope R. (*Sealed October* 22, 1886).

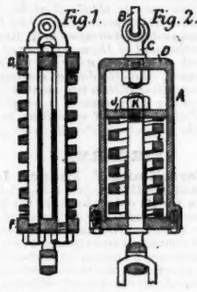
515. R. R. Gubbins, London. Improvements in the Driving, Construction, and Arrangement of Refrigerating Machines. [1*s.* 3*d.* 25 *Figs.*] January 12, 1886.—This invention relates to the method of refrigerating by means of the expansion of compressed air. The cold air machine is placed within the "cold chamber." The improved cold air machine consists of at least three cylinders arranged round a common crank. The driving cylinder is supplied with compressed air from an air pump; one of the other cylinders draws in and compresses air from the atmosphere of the "chamber." The heat thus developed is abstracted from it by forcing the air through a cooler outside the "chamber," whence it is admitted to the third cylinder, in which it is expanded and exhausted into the "chamber." Circulation is produced in the atmosphere of the "cold chamber" by means of a rotary fan which may be driven by the "cold air" machine. (*Accepted November* 12, 1886).

977. J. Nichols, Birmingham. Improvements in Nails. [8*d.* 7 *Figs.*] January 22, 1886.—According to this invention the nails are made from various sections of wire or metal twisted so as to produce a spiral thread or groove. These nails may be driven into wood without splitting it. (*Accepted November* 16, 1886).

1066. A. H. Haigh, Eastbourne, Sussex. Providing Against Over-Pressure of a Fluid by Using a Glass Receiver in Place of a Safety Valve. [4*d.*] January 25, 1886.—Inventor claims the novelty of the application of a glass receiver or disc whose limited strength is security against over-pressure. (*Accepted November* 26, 1886).

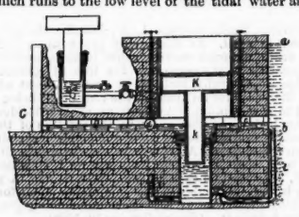
8760. R. Wotherspoon, Hartlepool, Durham. Shock-Deadening or Buffering Apparatus, Applicable for Use with Ropes, Chains, and other Appliances Required to Support a Tensile Strain. [6*d.* 3 *Figs.*] July 5, 1886.—This invention has for its object a spring safety buffer which, when linked in the line of a chain, rope, or other tension device, will deaden or buffer sudden strains, and yet the spring of which cannot be injured by any strain which the line is qualified itself to sustain. Referring to Fig. 2, a cylinder is attached to and forms part of line B by

Fig. 1. Fig. 2.



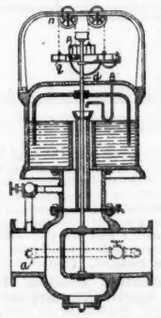
means of an eye-bolt passing through the closed end and fixed by a nut. An eye-bolt is attached to the piston J by a nut K. The spring L fits loosely inside the cylinder. A short piece of tubing M limits the strain on the spring, as, if the spring is sufficiently compressed for the piston J to come in contact with the tube M, the tube takes the excess of strain. If the piston be air-tight, or nearly so, there is, besides the spring, the compression of the air on one side and the tension on the other to assist the spring. Fig. 1 is a modification of this invention. In this case the spring is guided along a series of bolts uniting the two outer discs D, F. (*Sealed October* 12, 1886).

8850. H. H. Lake, London. (*J. H. Hagerty, Lowell, Mass., U.S.A.*) **Apparatus for Utilising the Power of Tides.** [8*d.* 2 *Figs.*] July 6, 1886.—To the right of the illustration is a water space in which tidal water rises and falls, the highest level being at *a* and the lowest at *b*. If now the water is at the head *a*, the float K and the plunger *k* at their lowest position, the valve *e* open and the valve *d* shut, water will be admitted by the pipe E so that the plunger and float will be buoyed up on the surface of the water, and will rise to the top of the pit to a level with the water outside, drawing in some water through the pipe H which runs to the low level of the tidal water as indicated



at L. The valve *e* being now shut and the valve *d* opened, the water beneath the plunger *k* will run off into the larger reservoir C (to the left-hand of the illustration) which should be of sufficient size to hold all the water necessary to be used during a tide, and to be readily emptied at low tide. As the water runs off into the pipe D past the valve *d*, the plunger *k* and its float K will fall, exercising the pressure due to their weight upon the water in the pit F and forcing it out through the check valve *i* into the reservoir D^3 for storing hydraulic power. This operation being repeated will serve to pump water. The valves *d*, *e*, may be moved by hand or otherwise. (*Sealed October* 12, 1886).

9288. J. T. King, Liverpool. (*J. L. Connelly and T. E. Connelly, Brooklyn, New York, U.S.A.*) **Improvements in Gas Governors.** [8*d.* 10 *Figs.*] July 17, 1886.—This invention relates to that class of automatic gas governors in which the valve is actuated by a float caused to rise and fall, and thereby close and open the valve by the pressure in the service main. The improvements consist chiefly in the employment of compensating weight



vessels *p*, *q*. The vessel *p* has several compartments communicating with each other, and is fastened to the valve stem *d*, and is connected to the vessel *q* by chains passing over sheaves *n*. Liquid is caused by means of cocks to pass from one compartment to the other according as a light day pressure or an increased night pressure of gas in the supply service main a^1 is required. (*Sealed November* 19, 1886).

UNITED STATES PATENTS AND PATENT PRACTICE.

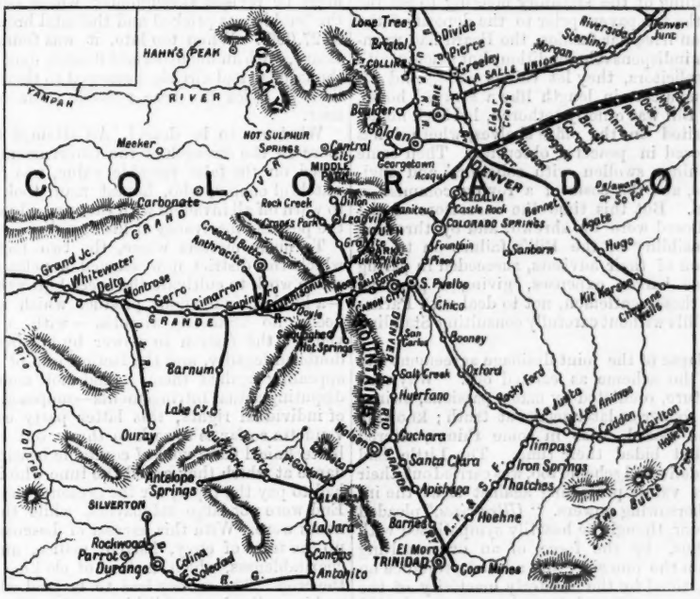
Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

COAL MINING IN COLORADO, U.S.A.

WESTERN America as a source of fuel supply may seem to many as unimportant, so little is known of the great extent of country familiarly spoken of as the Rocky Mountains, and many years must elapse before any just idea can be formed of the extent of the coalfields of that district. Discoveries and developments already made prove beyond a doubt, however, that they are of great extent and include coal of many different varieties.

It would be impossible in one article to give any minute account of the numerous coalfields known to exist in these regions, and for the sake of brevity we will confine our remarks to the better known coalfields of Colorado, which have been more extensively worked than those of adjoining territories.

In this State the coalfieds on the Atlantic slope of the mountains are the best known and have been most extensively worked. All the veins which have been opened either crop out at the surface or



are of moderate depth, and little has been done to ascertain whether lower veins exist. The geological formation in various sections would indicate that coal may be found with depth in localities not now reckoned as coal lands.

The most southerly coalfield in the State on the Atlantic slope is that lying around Trinidad. Here a good grade of bituminous coal is found in flat veins from 6 ft. to 10 ft. thick, cropping out of the mountain side. These mines yielded in 1884 about 450,000 tons of coal, a large percentage of which was coked at the mines. To the north of these are the Walsenburg mines, where the coal is semi-bituminous, lying in flat veins from 4 ft. to 6 ft. in thickness.

The Coal Creek mines, near Cañon City, are the next of importance north of Walsenburg. Here a number of mines are in operation. The coal is a lignite of fair quality, lying in flat veins; the product of these mines in 1884 was about 300,000 tons. Still north of Coal Creek is the coalfield lying east of Colorado Springs. Here there is an extensive vein of soft lignite from 6 ft. to 8 ft. thick, which crops out at the surface.

From the town of Lidalia northward to Erie, a distance of about forty miles, an extensive coalfield exists, which around Golam and to the north has been extensively worked. The coal is a lignite of good quality, lying in two seams, one 4 ft. and the other 8 ft. to 10 ft. thick. The veins throughout the greater part of this field have been upturned and lie at various angles from 40 deg. to 80 deg., the dip being generally to the west or into the mountains.

The next coalfield of importance which is being extensively worked is that lying around Crested Butte, in Gunnison County. This field lies right in the heart of the Rocky Mountain range, and possesses many interesting features which will be dealt with further on.

There are in this section a number of veins varying in thickness from 4½ ft. to 8 ft., and in character from very poor lignite up to anthracite containing 90 per cent. carbon.

The extent of this field has never been determined, but outcroppings of coal lying in the same formation have been traced over a country sixty by a hundred miles. Of course this area is not all coal lands, as numerous volcanic disturbances have left the strata very much broken up, as may be gathered from the fact that the elevation of the coal veins around Crested Butte varies from 5000 ft. to 9000 ft. above sea level. The total produce of these mines in 1884 was about 100,000 tons.

In the south-west corner of the State around the town of Durango a very extensive coalfield exists. This field has been but little worked on account of its being very inaccessible, and though reached by rail, heavy haulage charges prevent the coal being marketed in the more thickly peopled parts of the State.

In a recent inspection of the strata near Durango no less than twenty-two veins were found, of which only six were under 5 ft. in thickness, the others ranging all the way up to 90 ft., the thickest vein of coal yet found in Colorado.

The coal in this section, so far as known, is all lignite, some of it of very good quality. The 90-ft. vein above referred to is very poor in quality, especially the upper portion of it.

The coalfields which are known and worked are, as may be seen by reference to the map, widely scattered over the State. Many others not here referred to have been found, especially in the north-western part, but as settlers are few, little is known to the public regarding them. Middle and North Parks are both reported to have very extensive deposits.

The coals of Western America are mostly all found in the cretaceous formation, extending up in some cases into the lower tertiaries, though some geologists seem to hold the opinion that these coals belong to the tertiary period entirely. That the carboniferous measures are entirely absent here there seems to be little reason to doubt.

That anthracite coal should be found in these recent formations may seem strange to many, as it no doubt is unusual, but the anthracite region around Crested Butte presents even stranger phenomena, in that they demonstrate that a lignite and an anthracite coal are substantially the same in origin, subsequent conditions alone effecting the change.

In this interesting section the coal changes in the same vein from a pure lignite to bituminous, and from bituminous to anthracite containing 90 per cent. carbon within a distance of a few miles, the change having been effected by the proximity of the coal to intensely heated volcanic matter.

The lignites found in Colorado vary widely in quality, but in any of the mining sections above mentioned good steam coal is procured which answers very well for locomotive and other boiler purposes.

An analysis of the lignite mined at Golam was as follows:

Water	12.165
Fixed carbon	51.989
Volatile matter	31.776
Ash	3.900
Specific gravity	1.314

The entire coal mined in the State in 1884 is estimated at 1,352,000 tons, while that of 1885 will slightly exceed 1,500,000 tons.

Recent developments have shown that the adjoining territories are also rich in coal deposits. The amounts mined in three of these in 1885 were as follows:

	Tons.
New Mexico	284,000
Wyoming	857,000
Montana	88,000

THE NATURAL HISTORY OF LOCAL BOARDS.

III.—THE FIGHTING BOARD.

(*Concluded from page* 30.)

AFTER nearly a year's delay, the inquiry was held. Their veteran clerk, who had led the Fighting Board into many a tough conflict, no longer advised them; and a new man, verdant in local government affairs, occupied his place, facing no less than ten branches of the opposition, each duly represented by counsel or solicitor; and the engagement lasted two long days. All the humours of an annexation fight manifested themselves. The Great Endians were in a minority, as might be expected, and loud and scornful laughter greeted their claims to superiority and right of headship. "Manage your own affairs first, and then tackle us," was the reply. Their rates were magnified and their rateable value depreciated; their water was sneered at as but a few removes from sewage, and scarce at that; their roads were held up to scorn as impassable, and their long years of litigation and their present suits were raked up and cast in their teeth; the formidable sum of 3000*l.* being cited as costs alone paid by the unlucky ratepayers during the preceding five years, besides outstanding claims amounting to more. Well might they want assistance from without. But the climax of humour was reached when a sturdy witness said that the Great End market "generally boasted a circus, and a place where boxing was done," but was a mere bagatelle, having tried a pig market and failed miserably; while the court was convulsed by one convivial opponent's truthful declaration that he rarely drank the Great End water alone, although he lived in their district. Finally their motives were impugned, and it was reiterated that their own rating relief, and not the public good, was their object, and that having villanously neglected their duties for the whole period of their existence, the Board now sought to carry out the necessary internal works at the cost of the new district proposed; to which the obvious reply was that their neighbours had contributed their share in bringing things to the present pass.

The inspector was a man of large views and experience, who had little faith in the multiplicity of little authorities, and it was reasonably thought that the order for the extension would be issued. But many things go to the making of all things. The order never came, for after the full consideration of that great body which reigns at Whitehall, it was decided that the evidence had afforded no sufficient ground why the present divison of this grimy little beehive into several local government districts should not continue. What happens *in camerâ* the public know nothing of, but it was bruited that every spring or source of influence was moved to bear upon the decision; a means which, as all believers in the universal purity of Governments must allow, is love's labour lost. No access, however, to the inspector's report could be got.

Meanwhile another great suit was running its halting course through the famous halls of Chancery.

When the joint drainage scheme was revoked, and no argument could bring the Little Endians to reason, the Fighting Board stuck to their colours, and aimed a mighty blow with that blind and arbitrary force which recoils upon its authors. At a fortnight's notice they heroically cut off their neighbour's connection with the sewer jointly used for temporary purposes, and left the Little Endians to welter in their sewage. It was their own property, said they, and they could do as they liked with it.

What might happen in consequence; what works might be stopped, or what disease break out, or death ensue to a community absolutely dependent upon that little 18 in. tube for its relief, was no business of theirs. To them it sufficed that the tube was their own, that their neighbours only used it on sufferance, and that they had deliberately revoked a joint agreement deliberately entered into. So, not looking where they leaped, they cut Little End off incontinently.

But they reckoned and acted unwisely. Logical as the law is even to the *reductio ad absurdum*, it recognises the imperious needs of a community. When, therefore, the alarmed rulers of Little End applied for an injunction to restrain their opponents from stopping the flow of their sewage, their petition was at once granted, and an interim order issued. Of course the affidavits were contradictory. The Great Endians said nothing as to the annexation scheme, or the revocation of the joint drainage scheme; but enlarged on the incapacity of their temporary sewer, which undoubtedly, by its connection with the river, was unfit for its purpose; and equally, of course, the Little Endians made the most of the curious fact that the incapacity of the sewer was only discovered by their enemies when baulked of their joint drainage scheme.

In a couple of months the defendants were again cited, but the motion was allowed to stand over for six weeks longer, at the end of which the antagonists again confronted each other in the High Court of Justice, when the judge wanted to know what had been done in the mean time.

"Nothing," said the Great Endians.

"Everything," said the Little Endians. "That is, everything which can be done, which, indeed, is very little in the scanty time allotted. We have got an engineer. He has prepared a scheme. The Board have unanimously adopted it (they were always unanimous in those parts in those times, in fighting their neighbours), and but a week ago the plans were sent up to the Local Government Board at Whitehall for their examination and approval. What more can we do? Our opponents do not attempt to show a better scheme, and it will be impossible to carry it out within twelve or eighteen months."

Whereupon the Vice-Chancellor, instead of coercing the defendants to return to the joint drainage scheme, which irregularity might have saved a few thousands of pounds to the ratepayers of both districts, and increased the efficiency of both schemes, granted a third respite of two months; and so the ebb and flow of counsel to the High Court of Chancery went steadily on at regular intervals until a revolution occurred at Great End that stopped all further proceedings, and left their victorious little opponents in undisturbed possession of their separate drainage scheme, which they prized as most people prize a white elephant—until they realise what it costs to keep it.

Under good feeding, we "wax fat and kick." Long years of feverish prosperity had brought the Big Endians into that goodly condition in which, their place being too little to hold them, they struck out manfully. But bad trade had been setting steadily in, and as poverty stole over the little community, heavy rates daunted them, and their fighting spirit died away. Wearied of a warlike policy, which enriched their lawyers and left them poor, they listened to agitators, and at the next election the balance of power was changed. The Fighting Board was split in twain, and the old chairman dethroned, his place being filled by a democrat whom the late Board had pilloried by a vote of censure. But the minority showed fight, and taking advantage of their inexperience of office, so harried the majority that the proceedings of the Board became little better than a farce, at which the ratepayers payed the performers. As usually happens after a change of ministers, the acts of the last Board were marked out for contumely and revocation. Personal feuds entered, and the Board-room became the battle ground not only of party but of private interests. Every technical point was used as a weapon of offence and defence, and resolutions and counter-resolutions were proposed, the legality of resolutions questioned, and even the legality of meetings.

One of the first acts of the new Board was to withdraw from all lawsuits with a zeal so open and ostentatious as to invite aggression by proclaiming peace at any price. Then they became the aggressors themselves, as anti-coercionists speedily become coercionists when they get the power. The gas company of the district were to some extent in their hands, having no Parliamentary power of supply and distribution. The directors were chiefly of the faction of the old Board, and knowing the motto *væ victis*, they wisely determined to arm themselves for the conflict they saw before them, by applying for an Act the very next session. Seeing this, the Board not to be behind with them, first tried to negotiate for the purchase of the works, an offer which the company, knowing the value of an Act of Parliament, declined to entertain. Then the Board in another of those hasty moods characteristic of Great End legislation, resolved to go to Parliament for a rival scheme, which they might possibly have got but for one thing, namely, that Parliament never saw it.

The Board, solicitors, agents, and engineers were all new to the promotion of Parliamentary Bills, and consequently managed to do the thing they ought not to have done, and not to do all those things they ought to have done; one of their omissions being vital to the whole question. This was the calling of the statutory meeting to get the assent of the ratepayers prior to the deposit of the Bill. In an irregular fashion, the Board had warning of this indispensable condition, but placing faith in their solicitors, they let things slide; and so, having gone a certain length like a strayed horse, this little Bill was quietly tethered, led back home, and deposited on the office shelves, where it has since reposed in peaceful obscurity. Then came the reckoning, swollen with solicitors' and engineers' bills, and the costs of a roving commission in London. But this time the successors of the Fighting Board were too shrewd, and by throwing the responsibility of the Bill's failure on to the misdirection of their advisers, succeeded in paring down these barren expenses, giving a practical lesson to these gentlemen, not to deal with Parliamentary Bills without carefully consulting Standing Orders.

The collapse of the joint drainage agreement did not alter the scheme as carried out. Wayward human nature, oscillated by many passions, swings back, and sooner or later settles at truth; knowing which, the Board, wise in some things, altered nothing, but bided their time. The Little End Chancery-delivered scheme too, was carried out, their neighbours vainly protesting against it at the inquiry for borrowing powers. "*Ultra vires*," pleaded the inspector, though he heartily sympathised with unity. Thus, by the force of an over-vaulting ambition on the one side, and a blind prejudice on the other, aided by the masterly inactivity of the Local Government Board, two schemes were planted in one little district, and the Little Endians triumphantly carried their outfall past the head of the Great End outfall at a level of 2 ft. above it, and then diverted it, sending the sewage to a costly pumping station and tanks built down in the marsh, whence they—when it suits them—now lift it up on to some other marshy land a mile distant. And it is thought by some, this surplus scheme, conceived in sin and born in haste, is now leisurely repented. As sin sticketh close between buying and selling, so doth sorrow cleave fast to the hasty man.

About this time the new clerk, not a lawyer, but an honest, decent, and altogether too complaisant sort of man, found it convenient to take unlimited leave of absence without notice. A collector did the same, forgetting in his haste to render to Great End the things which were Great End's. And lastly, the new chairman, who came in with such regenerative grace, found his oil spent, and went across the Atlantic with a mystery and haste not exceeded by any of those who had gone before him; all of them finding Great End a very good place to leave. These desertions only tended to make confusion worse confounded, although, as will hereafter be seen, they were not devoid of some compensating balance.

No sooner was the main drainage scheme completed than the Board put themselves in possession of a complete set of plans for the drainage and improvement of about 100 private streets, while the house connections in the public highways were busily in hand. But alas! hard times had overtaken the district. A mountain of debt hung over it, and owing to an unforeseen circumstance its energies for good became smitten with paralysis, and the great private improvements scheme fell stillborn into an unsympathising world.

Besides the drainage works, the Board were carrying out a new market hall at a cost of 10,000*l.*, the outcome of the "leaping and bounding" prosperity which had gone. They had also made a new street, a very desirable but costly improvement involving the demolition of old buildings and an outlay of 2000*l.* or 3000*l.* The sewage land cost nearly 2000*l.* more than the estimate, and although the total cost of the drainage estimate was not greatly exceeded, yet Great End had to pay the whole instead of having a partner to share the cost. All these undertakings swelled the old debt fourfold. Now in conceiving their great designs the old Board had an eye to their rateable value. Independently of the great increase of new buildings, there had been a re-valuation of the union, out of which Great End had issued with an advance *per saltum*, from 24,000*l.* to over 30,000*l.*, a few strokes of the pen making something out of nothing—a process of evolution unknown to Darwin. On this basis the Board acted, sailing close to the wind, and dipping their estate nearly to the limit of what they conceived to be its value. But soon notes of alarm reached them. Appeal after appeal was lodged until it became evident that the inflated valuation must be revised throughout; which being done, the bubble was pricked and the total brought down to 27,000*l.* When too late, it was found that the Board, with an unauthorised floating debt of several thousands, had already borrowed to their statutory limit of twice the true rateable value of the district.

What was to be done? An attempt to borrow more on the strength of the Government sanction based on the false rateable value, was foiled by a watchful enemy, who, honest man, took good care to warn off all invaders with that two-edged weapon, the possible insolvency of his own district.

To make matters worse, the two factions into which the district now seemed hopelessly divided set to work to cultivate the special growth of rates—a kind of indigenous product which apparently needs no artificial stimulus—with all possible vigour; the faction in power by levying rates of doubtful legality, and the faction out of power by appealing against them. And not content with disputing actual infringements—supposed or real—of individual rights, this latter party carried the vendetta so far as to seek to throw out every rate by technical flaws void of equitable bearing; a legal dance at which they called the tune who in the end had to pay the piper, for the present rulers of Great End were not large ratepayers, while their opponents were. With this harvest of dissension sprang up the tares of envy, hatred, malice, and all uncharitableness, which, instead of choking, fertilised the crop. The money had to be paid whether the making, allowing, publishing, and levying were or were not such as made the rate void in law. Not even the twenty just reasons alleged by one counsel against the validity of a rate could get over the ultimate payment of the just and lawful debts of the district, and although the fact that one appellant himself paid a twenty-fifth part of the whole rates gave him a good *locus standi* before the justices, yet it constituted a better reason for his quietly paying his rate without the superfluous addition of law costs.

At last a rate was disputed with such grave reasons, that the justices at quarter sessions fought shy of a decision, the greater part of this very rate having been already paid. They recommended arbitration as a healing policy. This completed the deadlock, and the whole machinery of administration was stopped; the water works were distrained for debt, and things came to such a pass that one despairing member of the Board actually proposed to call in the Local Government Board to administer the affairs of the town for a term of years! But this *fainéant* policy did not prevail, although at that time a 9*s.* rate for district purposes alone was hanging over the district. A surcharge had been made at the last audit, on certain illegal payments; against which surcharge an appeal had been made to the Local Government Board, accompanied by a petition. An inquiry was held, at which the doings of the ill-fated district were exposed on both sides. The inspector was a discreet man, forewarned of the feudatory conflicts of Great End: he was also a peacemaker. Sympathising with the Board's difficulties, he demurred to certain proven liberties with the truth; was impressed by the stopping of certain cheques by the signers themselves; inquired narrowly into curious discrepancies into the rate-book; looked grave when the burden was clapped on to the shoulders of the errant late clerk; and objected to the misapplication of loan funds, and to interest paid out of capital,

which said capital was alleged to be lying useless on the tables of the Board; but he kept his own counsel as to the surcharges, and thanking the opposing parties for their mutual forbearance—having heard desperate things of them—he withdrew, hoping that in course of time the district would become unanimous.

The relief sought for from the Local Government Board only affected the surcharges, which were remitted. As to the load of debt staring them immovably in the face, the department could only recommend two courses: (1) the laying of so vigorous a special rate as would at once pay their pressing debts; or (2) the promotion of a private Bill in Parliament for increased borrowing powers; at the same time reminding them, as they already knew, that they could borrow on mortgage to the extent of three-fourths the purchase money of any real estate of which the Board might be possessed. But the disputed rate stood like a lion in the path. Nothing could be seen beyond it, for their credit was undermined, aud they were stricken with poverty. Arbitration was grasped at, as suggested at quarter sessions, but the appellants rejected it with silence, perhaps counting the cost of the endless pilgrimages to the shrine of law. Perhaps the interval gave all parties food for reflection, and the remission of the surcharges did undoubted good. But the next election broke the spell. The old party came back to power sobered by experience. The friction was at once reduced, and the Board was left free to grapple with the incubus of debt which menaced them, just in time to save the district from insolvency.

A rate transcending all recorded rates in magnitude cleared off urgent demands, and restored the district's credit. Owners of lands bought and not conveyed, contented themselves with good interest for a time, holding their title deeds as security. In this manner Great End piloted its way. Whimsical economies were introduced, including the retrenchment of the official staff. The surveyor was dismissed, being of the deposed faction, and the clerk summarily installed in his place, without salary. "I know nothing of the duties," said he, in dismay, "and I protest against the thing." "Protest as you like; but do it, or go," was the peremptory reply; and so by another of those hasty fiats which had characterised the Fighting Board, the clerk and surveyor were rolled into a single entity. By this wise act, no less than 100*l.* a year was saved, and the health and communications of the district placed in the hands of a man who disowned his own competence; an act done without the least regard for the sure and certain heritage of sanitary woes bequeathed to the future. A costly and elaborate main drainage system on the duplicate principle, and in a flat and flooded district, without the branch drainage, and most of the house connections to make; this in the control of a clerk, is like a watch in the hands of a child, easier to destroy than to repair. Of such economies is ruin built.

We have still to record the last of the Chancery suits which seemed the native element of the Fighting Board. This time, however, they were the defenders of a just cause, and for the first time in their history, gained their suit, proving that, after all, the devil is not so black as he is painted, and that good can come out of Chancery. It has been mentioned that the ambitious designs of the Board included a market hall, at an estimated cost of 1000*l.*, which along with all other designs for structural work, was put into the hands of their engineer. In due time the contracts were let and the foundation stone laid with much talk and blowing of trumpets, as befitted so august an occasion; but no sooner had the foundation walls appeared a few yards above the ground than the works came to a sudden standstill. The contractors were two partners — Great Endians — leavened with the fighting spirit of the district. One of the two failed in his private concerns, and the other dared no longer proceed with the joint contract. The engineer, after strong representations and a delay of several weeks, put his power into force, and gave notice to the Board that inasmuch as the works were not proceeding with satisfactory speed, they should be taken out of the contractors' hands and re-let. The Board acted on this recommendation, noticed the contractors, and advertised the re-letting of their contract; upon which the solvent partner made the inevitable appeal to Chancery for an injunction to restrain the Board.

When the motion came on, the Master of the Rolls asked for the specification and contract, and for the notice of the engineer. In the first he found the words: "Should it appear to the engineer that the work is not proceeding with satisfactory speed, or that it is not being executed according to the terms of the specification, the Board may seize and take possession of the works," &c. From the second he found that the engineer had certified to the Board that the work was not proceeding with "satisfactory speed." This was enough. Said the judge: "'Should it appear to the engineer.' Therefore all I have to ascertain is that it did appear to the engineer. I cannot take the opinions of other engineers that it ought not to have so appeared to him. The question is, did it? And of course that means *bonâ fide*. That it was not, there is no pretence. . . . . Under all the circumstances it being proved that the work has not proceeded with speed satisfactory to the engineer, the Board were entitled to give the notice, and the plaintiff having entered into that contract knowingly, is not entitled to ask a court of justice to make a new contract for him. I dismiss this motion with costs." Thus, by a sound specification and a just decision, the Board gained their first victory, and returned to their enterprise with the consciousness that fate had not decreed that they should always be in the wrong, and that they had saved their district from what might easily have been the most complicated of all their suits. This, however, was during the interregnum of the Fighting Board.

Substantial justice was done by re-letting the contract to the solvent partner—the plaintiff in the suit—all loss, if any, being deducted from the fund retained in respect of the first letting.

Other difficulties arose, of a nature interesting to engineers and to partners generally. But of these, and of a curious and perhaps innocent attempt to get paid twice over through the puzzle of partnership, we have not space to tell. So thick-coming were the plots, counter-plots, humours, stratagems, surprises, and all official complications of Great End, that no less space than the time-honoured three volumes, post octavo, filled with the pen of a Dickens, could do justice to the story. To use an old phrase of the poets, the chronicle here presented is but the "argument" in this great epic of a Local Board.

Thus, like an exhausted volcano, the Fighting Board remains; its fires run down, and its arena strewn with ashes. But whether its fires are only smouldering, not extinct; whether its present virtue is like that of the strong man enfeebled by excess, remains to be seen. At any rate, the gods have not destroyed its members, although at one time they seemed smitten with madness; and their secret and invisible enemy who so long pursued them has rested, and no longer treads close behind them. But their sins of omission block the way to all improvements; for, by the wise decree of authority, no further borrowing powers will be granted for any purpose until their drainage scheme be completed. Just now, it lies at the mercy of ignorance and recklessness. What will become of it? The way of transgressors is hard.

STREET CLEANING IN PARIS.

By H. VIVAREZ.

(*Continued from page* 40.)

THE removal of household refuse is a matter which has attained to far more importance in Paris than in London. The density of the population is much greater, while the consumption of vegetables, which gives rise to a large amount of waste matter, is much more considerable. Previous to the year 1870 the inhabitants of Paris were permitted to place their domestic refuse on the edge of the pavement in front of their houses, provided that they did it in the early morning. In reality those deposits commenced to be made as soon as the obscurity of the evening favoured the act, and a serious nuisance was thus created. In the year 1846 the authorities had attempted to oblige the inhabitants to keep their waste in their houses until the moment when the dust-cart passed to collect them. That regulation was renewed in 1870, on account of the public health during the siege of Paris. But alike in 1846 and in 1870 the law was a dead letter, particularly in the more remote districts. It was not only opposed by the negligence and ill-will of the inhabitants, but there was mixed with these a question of another order.

There exists in Paris a special industry which supports about 15,000 persons, and produces seven or eight million francs per annum. It is the rag-picking (*chiffonage*) carried on by a nocturnal population which sally forth at dusk, basket on back and hook in hand, to pick out from the heaps of refuse, by the light of a lantern, rags, paper, bones, in a word, anything which can be utilised in the slightest degree. Contrary to what might be expected, the population is generally composed of thoroughly honest people, of excellent character, and this has always contributed to secure for the craft of *chiffonage* the sympathy of the press and the public. It is to the interest of the rag-pickers that the refuse should lie in the street as long as possible, in order that they may turn it over and over, and by a patient search extract everything of value. This consideration has always had great weight in the amount of observance accorded to the regulations. Recently the law has been put vigorously into force by M. Poubelle, Prefect of the Seine, and the question of *chiffonage* has been again discussed by the press most vigorously. This time, however, the authorities of the city have prevailed, thanks to their energy and moderation. The new rule is dated March 7, 1884, and its chief provisions are as follow: (1) It is forbidden to throw into the public thoroughfare, at any time of the night or day, either domestic refuse or sweepings from the interiors of buildings. (2) From the present date the landlord of each property must deposit every morning, either on the pavement outside, or within the doorway, at a point perfectly visible and accessible, one or more receptacles of sufficient capacity to contain the household refuse of all the tenants of the building. These receptacles must be placed at least one hour before the official time of collection, and must be carried back into the interior of the building within a quarter of an hour after the passage of the dust-cart. (3) The receptacles must satisfy the following conditions: each must have a maximum capacity of 120 litres (4.23 cubic feet) and must not weigh more than 15 kilogrammes (33 lb.) empty. If it be circular it must not be more than .55 m. (21.6 in.) in diameter, and if elliptical or rectangular it must not exceed .50 m. (20 in. in width, nor .80 m. (31.5 in.) in length. In any case the height must not be greater than the smaller of the two horizontal dimensions. The receptacles must have two handles at the upper part. They must be painted or galvanised, and bear in plain characters the number of the house and the name of the street.

These rules are in force and cause no difficulty in execution. The population of Paris have adapted themselves to the new order of affairs; the opposition of the *chiffoniers* is gradually dying out, while public sanitation has realised a sensible improvement.

(*To be continued.*)

LITERATURE.

On the Conversion of Heat into Work. A Practical Handbook on Heat Engines. By WILLIAM ANDERSON, M. Inst. C.E. London: Whitaker and Co.

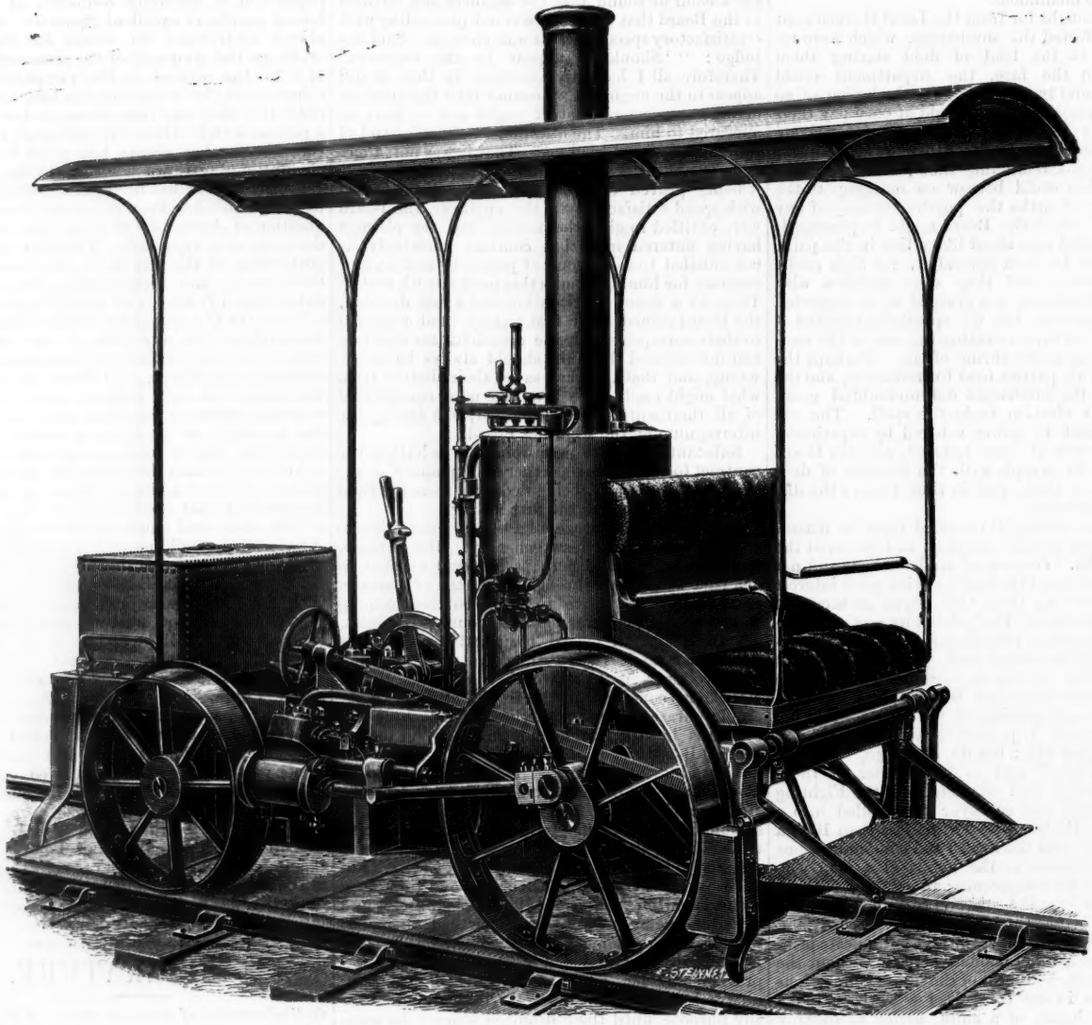
THIS work is substantially a reproduction in book form of a course of most interesting lectures delivered by the author at the request of the Council of the Society of Arts. The object of the lectures was to popularise the modern doctrine of the conversion of the molecular motion of heat into mechanical work, and to illustrate the applicability of the doctrine of Carnot in regard to the limits within which improvement in the economical working of heat engines is possible. The book is the work of a thoroughly practical engineer of high standing in the profession. The author has written it evidently on the same lines upon which he has been accustomed to think out the many important engineering problems which have presented themselves to him in a long and varied professional experience. The lectures and the book have been to him a labour of love, and the numerous interesting questions discussed are just those prominent features in practical engineering which most attract the intelligent mind, and by their study elevate the mechanic into the engineer. If only as a list of headings of points to be understood, the book would be valuable to any one desiring a knowledge of the principles according to which the forces of nature are converted into the forces of man.

It is impossible to convey information upon the mechanical conversion of heat without employing to some extent mathematical language and symbols. Knowing that to many of those whom he would like to address, high mathematics would be a hindrance, the author has endeavoured to convey his meaning always in simple language, and as far

PERMANENT WAY INSPECTOR'S STEAM CAR.

CONSTRUCTED BY MESSRS. MERRYWEATHER AND SONS, ENGINEERS, LONDON.

(*For Description, see opposite Page.*)



as possible to deal with all problems quantitatively by plain arithmetic. Sometimes he has to resort to simple formulæ involving powers and logarithms, but only when a simple method could not be made applicable. Wherever the author leads, the reader will always be able to follow and to feel on solid ground at every step.

Like many eminent engineers, the author is, however, sometimes wrong even when dealing with questions about which he is most confident. This is a fault which can be turned to advantage by the reader, for such mistakes are the very errors practical engineers are most apt to make, and they are much easier to discover when formally stated, for our scepticism is more likely to doubt the assertions of another than to discover the fallacies which lie in our own methods of thought. An endeavour to thoroughly master the application of first principles is conspicuous in every chapter of Mr. Anderson's work, and the spirit of it all is most healthful to a young engineer. Several hydraulic paradoxes, generally very imperfectly understood, are here made plain. Some of these we remember as apprenticeship puzzles, for years inciting curiosity to study to discover their explanation, and we do not now regret that they were so long inexplicable to us. In regard to matters like these the volume before us is a capital book.

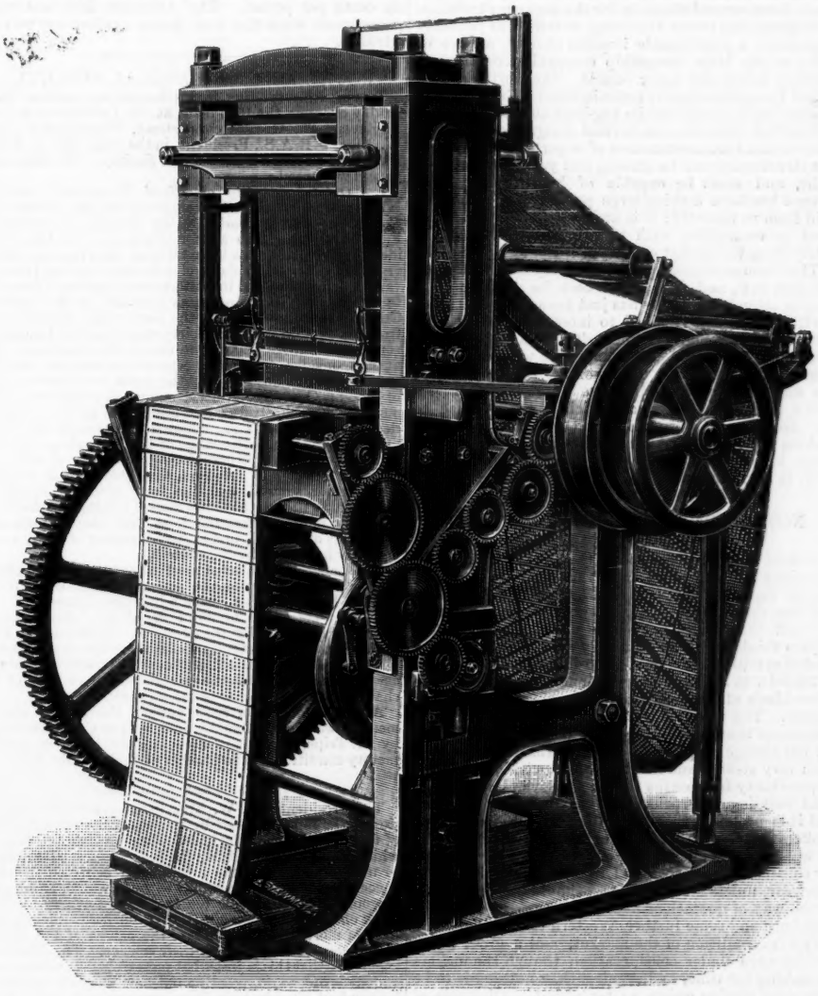
On the special subject of the book, the conversion of heat into work, we of course are agreed with the author that there is such a conversion in almost every mechanical operation. When we come to compare his views with our own in regard to the action by which heat is converted into work in that greatest example, the steam engine, we, however, entirely disagree with his statements. In an unjacketted steam cylinder he tells us the entire work done in each stroke is produced by the successive heating and cooling of the metal of the cylinder and the piston. The expanding steam, he says, does not fall in temperature, but the cylinder and piston do, and on the first admission of steam a portion of it is condensed upon the metal surfaces, heating them to such a temperature that they can afterwards supply heat to the expanding steam and prevent any fall of temperature while performing work. In each of the three typical indicator diagrams discussed by him the terminal pressure is at least as high as it would be if the working fluid were a permanent gas expanding isothermally. This feature having been so frequently explained in our columns and being so well understood by our readers, we are astonished to read the following statement in regard to the indicator diagram of the unjacketted steam cylinder: "Since the pressures, in expanding, have varied as the ordinates of an isothermal curve, it follows that the temperature of the steam has not altered, and consequently none of its heat has been converted into work; but the heat which has been so converted must have been derived from an extra volume of steam which was condensed by the relatively cold surfaces it came in contact with, which surfaces again gave it out as the volume of the steam increased, and so compensated for the waste caused by the conversion of some of the heat into work; in other words the surfaces of the cylinder acted as carriers of heat from the boiler to the expanding gas."

The author evidently believes that steam in a steam cylinder acts as a gas does in expanding, and that the temperature is, therefore, always proportional to the arithmetical product of temperature by volume for a constant weight of steam. This is quite wrong, there cannot be an isothermal curve for non-superheated steam expanding. One of the very first principles to be mastered in connection with this subject is that the temperature of expanding steam at any instant is exactly the temperature which goes with the pressure at that instant in the table of pressures and temperatures for steam. There is no difficulty, therefore, in translating an indicator diagram into temperatures according to such a table. The author stumbles at this point and directs his readers to take the temperatures as if steam were a permanent gas, and to conclude that "since the pressures, in expanding, have varied as the ordinates of an isothermal curve, it follows that the temperature of the steam has not varied."

On the indicator diagram from an unjacketted cylinder given in the book under notice, the pressure falls from 40.5 lb. to 12 lb. absolute, the temperatures were therefore, without any doubt, say 268 deg. and 202 deg. Fahr., nevertheless the author says that in this case "the temperature of the steam has not altered." This will not bear discussion. The cylinder was not jacketted; the condensed steam could not heat the

PUNCHING MACHINE FOR REPEATING JACQUARD CARDS

CONSTRUCTED BY MESSRS. SHEPHERD AND AYRTON, ENGINEERS, MANCHESTER.



metal above the temperature of the initial steam; and yet he says that the expanding steam did not fall in temperature; the expanding steam must therefore, according to his theory, have been heated by the walls of the cylinder to a temperature higher than that of the walls of the cylinder! The author then calculates the quantity of steam condensed initially to yield the heat equivalent of the work done during the stroke. He compares the amount arrived at with the efficiency according to Carnot's principle, and he finds that the two results differ by only 2 per cent. Even the 2 per cent. he accounts for by the uncertainty as to the temperature of the exhaust steam in the cylinder. And in this way we secure another proof that figures can be made to prove anything.

The other diagrams given are from cylinders having the surfaces jacketted all over. On these the terminal pressure is higher than that due to "isothermal" expansion. He says, "The rise of pressure above the isothermal cannot be due to an increase of temperature, but must be caused by the evaporation of water carried over by the steam from the boiler. In these cases the heat converted into work has been derived from the steam in the jackets transferred by radiation and convection from the metal of the cylinders, the condensed steam withdrawn from the jackets would, therefore, represent the quantity of heat converted into useful work."

We need not say that this is not how heat is converted into work in the steam engine. According to the author, the steam proper expands and does nothing more, it does not lose any of its heat during expansion, but is, for the time being, merely an agent to spend the heat received from the cylinder walls to pay for all the work done. This is certainly not the modern theory of heat.

There is a chapter devoted to calculations of heat, energy, and velocity in connection with big guns. The author has had a good deal of practical experience in relation to the Moncrieff system of gun mounting, and the chapter contains a great deal that is most interesting. We do not, however, approve of his reasoning about the velocity of the gases in the gun. He says: "When the muzzle of the gun is suddenly opened, the gases will begin to issue as from an orifice in the side of a vessel, with a velocity proportional to the height of the gaseous column $= 8.05 \sqrt{65,013} = 2125$ ft. per second, or very little more than that of the shot, which seems to indicate that the 10-in. gun cannot, with advantage, be increased in length without increasing the charge of powder." We suggest that this reasoning requires reconsideration on two grounds. The velocity calculated is dealt with as if that were the maximum absolute velocity, whereas it is the velocity relatively to the velocity of the gas which is itself moving, at the rear of the shot, at the velocity of the shot. Another point for reconsideration is the head of gas equivalent to the pressure. The author deals with the gas as if it were a liquid, the column equivalent to the pressure being 69,661 ft. of the internal gas. (The 65,013 ft. is a misprint.) For the velocity of efflux of a gas it is the height of the column of the expanded gas that must be taken. In this case the difference in efflux would not differ much from that stated because the propelling force acting on the gas has been taken as the whole pressure above the external atmosphere, instead of only about the half of that which alone would be effective. As a guide to principles, however, the calculation as given is misleading.

There are also chapters on refrigerating engines and gas engines, boiler furnaces, regenerative furnaces, dust fuel, liquid fuel, and an introduction expounding the principles of energy, potential and kinetic. It is difficult to write what will do equally well for a popular lecture and for a science primer. In attempting to do both there is sometimes a slip made which might otherwise have been avoided. For instance, in the book under notice, the author says: "But because the parts of a revolving body are moving at various speeds, it is necessary to find a circle in which the mean motion may be supposed to take place. This circle is called the circle of gyration." This is wrong; the circle of mean motion is not the circle of gyration. The radius of the one is .666, and of the other .707 of the radius of the cylindrical disc. In calculating the moment of inertia of the disc it would have been simpler to have explained that it is the same as that of a mere rim of half the weight. This relation is always useful to remember in comparing disc flywheels with rim flywheels. Again we have: "'potential,' the power of doing work latent in an advantageous position." . . . . "The heavenly bodies moving at uniform velocities for ever are instances of potential energy." This will not mislead; it will only amuse for a moment.

We hope to see a second edition of Mr. Anderson's well-planned book; the few exceptions we have taken to statements in it refer to only a very small portion of the whole, and no doubt the author will profit by our criticism.

PERMANENT WAY INSPECTOR'S CARRIAGE.

THE perfecting of light high-class machinery will doubtless do more in expanding the English engineering trade than dependence upon the export of the usual run of heavy engines, pumps, &c. Indents for the various foreign railways and colonial agencies frequently stipulate that machinery weighing in the total some 3 or 4 tons must be in loads not exceeding 5 cwt. to 10 cwt., as greater weights cannot be taken across country. Light high-class machinery overcomes this difficulty of transport, and perhaps in no class of machinery has the achievement been thoroughly accomplished as in fire engines and other pumping plant.

A few years ago an engine to throw 1000 gals. per minute would weigh complete some 9000 lb., now we get engines of equal capacity weighing 4500 lb.

Messrs. Merryweather and Sons, who have a well-merited reputation for this class of work, have recently designed and constructed, for a foreign railway, an inspector's carriage, which we illustrate on the opposite page. It is for a line of 1 metre gauge, and it is intended to be lifted off the rail when necessary to allow a train to pass. The two cylinders are 4 in. in diameter and 6 in. stroke, placed outside the frame; the boiler is Merryweathers' patent light tubular boiler as used on their fire engines; the shell is in two parts united by bolts and nuts so that the firebox may be entirely removed and the tubes cleaned when necessary. Steel is freely used in the details of the engine, and large bearing surfaces are given to journals and other wearing parts. The seat in front is to accommodate two persons, and the driver is placed in the rear of the boiler, with starting, reversing, and other levers in convenient positions. A light sheet iron roof and curtains are provided and also a tool box. The finish and workmanship of the whole engine are of the highest description, and no doubt a machine of this type would prove a useful addition to the rolling stock of any railway company.

JACQUARD REPEATING MACHINE.

THE demands of fashion are so fitful that if a manufacturer does not respond to them with promptitude he will often find himself with a large stock of goods which, although recently in great request, are no longer saleable. If he is to catch the market he must lose no time in turning out the patterns which please the fancy of the hour, and for this purpose it is necessary that he should be able to set his machine to produce any class of work without delay. There is necessarily some delay in changing from one pattern to another, particularly in such machines as looms and lace frames, where the pattern has first to be transferred to Jacquard cards before the machines can be put to work at it. The production of a set of cards, even by aid of the piano machine, is necessarily slow, and if it has to be repeated as many times as there are looms to be supplied, many days may elapse before a sufficient supply is produced. It has, therefore, become customary to use an automatic machine, such as that of which we annex an illustration, to multiply the cards after one set has been produced on the piano machine.

Blank cards, with only the lace and peg-holes punched, are connected together in a chain of great length, and are stacked under the machine. One end of the chain is led over an ordinary Jacquard cylinder,

which feeds it forward intermittently as the punching is effected. The cards are punched between two die plates which rise simultaneously, the upper plate having a punch in every hole. The punches are vertical and each is connected with a vertical rod which is subject to the action of a selecting needle operated by the first set of cards. These cards are connected together in an endless chain and are pushed in succession against a bank of needles. When a needle is opposite a hole in the card it passes through the hole and receives no motion; the corresponding rod remains stationary between the punch and an abutment bar, and when the die plate rises the punch is driven through the card. On the contrary, if the selecting needle meets a solid part of the pattern card the vertical rod is moved off the bar, and the punch, having no endwise support, is raised and fails to penetrate the cardboard below it. By aid of this machine, which is manufactured by Messrs. Shepherd and Ayrton, of Gorebrook Iron Works, Longsight, Manchester, as much work can be turned out in six or seven hours as can be produced on a piano machine in a week.

NOTES FROM BERLIN.

BERLIN, January 24, 1887.

NEITHER of our two chief manufacturing districts, Rhenish Westphalia and Upper Silesia, can complain at present. Business has been fairly brisk all round. In the former district the iron industry has been exceptionally busy; forge pig has been in heavy demand, and prices keep very steady. Rolling mills are full up with orders, and prices were recently advanced 7s. per ton. There is a strong American demand for drawn wire just now, and excellent prices are obtained. Boiler-plate makers are not very busy at present. The convention standard price of plates was recently raised to 140 marks. Steel manufacturers keep moderately employed, but English competition in the steel rail department is felt very severely. As is known, in the contract for 11,800 tons of rails offered by the Berlin Railway Direction, Messrs. Bolckow, Vaughan, and Co. and the Darlington Iron and Steel Company tendered the lowest prices. But Germans do not like trade going out of the country if they can help it, and with the influence of the Trade Minister the contract has just now been divided between the two lowest German offers, viz., the Dortmund Company and the Bochumer Company, both of whom have reduced their quotations to the level of the English tenders. The one bright spot in the steel rail business was the order Krupp secured from the Victorian Government for 50,000 tons.

Turning to the Upper Silesian district, we find that, as in Westphalia, forge pig is most in demand. Lead is also in good request, and prices are firm. Several endeavours have been made recently to form a convention to elevate zinc prices, but as yet without success; the repeated attempts, however, have caused orders to come in pretty freely for future deliveries. Steel manufacturers here are fairly employed, several large orders having been recently received from private railways.

A briquette manufactory, the first of its kind in Upper Silesia, is now building close to the well-known "Laura" smelting works. The proprietors are the Cæsar Wollheim firm, in conjunction with the Schwartzkopff Company. We understand that this latter firm have received an order from the Italian Government for torpedoes to the value of 300,000*l.*, and that the company purpose establishing a torpedo manufactory at Venice. It was also reported that they had secured the contract for an extensive electric light installation at Hanover, but this has not been confirmed.

The hardware trade at Solingen is not particularly brisk at present; several rather large foreign orders were secured recently, but at ruinously low prices. The boot and shoe iron business seems to be going down the hill fast, owing to competition; several manufacturers have been obliged to discharge a considerable number of hands.

In all the coal districts an abnormal demand recently made its appearance owing to the severe weather, this was especially the case in the Zwickau neighbourhood, where producers have acknowledged themselves to be quite unable to cope with the demand, which is as much foreign as German. An enormous lignite mine was recently discovered near Posen; the mineral is said to be well adapted for the manufacture of briquettes.

As the strontian process is now gradually replacing the other methods in sugar mills, it is anticipated that the strontian mines in the Münster district will see a further development, although we believe they have not come up to expectations.

Messrs. Ludwig Löwe and Co., of this city, with the Mauser factory at Oberdorf, have received a joint order from the Turkish Government for 500,000 Mauser repeaters, and 50,000 ordinary repeating rifles; delivery to extend over four years. In connection with the recent establishment in Rome of a company to utilise the waterfall at Tivoli, I learn that Messrs. Siemens and Halske, of Berlin, have secured the contract for an electric light installation in the principal streets of Rome. The waterfall, whose force is estimated at 12,000 horse-power, will be used partly for the installation, and partly to supply the driving power of several factories. Messrs. Seck Brothers, of Darmstadt, have secured the order for the necessary turbines.

Shipbuilding in the Hamburg district will probably experience a considerable impetus shortly, as two or three of the large steamship companies contemplate building larger and faster vessels. The North German Lloyd Company recently commissioned a Geestemünde firm to build a large paddle tug-boat and ice-breaker.

The War Minister has invited designs to be sent to him for the best construction of a portable barracks; the structures must be strong, and yet comparatively light, and must be capable of housing 130 men. France has been making large purchases of sulphuric acid from us recently; it is understood that it is to be used in connection with the new explosive *melinil*, lately invented in that country.

The German cotton spinning industry is at a very low ebb just now, and, in fact, has been for some time. A largely attended meeting has just been held at Dusseldorf, when it was resolved to increase prices to correspond with foreign markets. The weaving trade is in a moderately good condition. The wool market is anxiously awaiting the result of the London sale, to see what turn prices will take. Jute manufacturers had a meeting recently, at which it was resolved to increase the prices of yarn, &c. Owing to the present fashion not requiring too much linen, the Berlin linen trade is very dull. The dress goods business, however, is fairly brisk.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, January 14.

A MOST feverish condition of the market is reported, especially in American steel rails and all kinds of foreign material. Only a moderate amount of business has been done during the past six days on account of the fact that prices have gone up higher than most buyers think can be permanently held. Steel rails are quoted at mill at 37.50 dols. to 40 dols., steel rail blooms at 30 dols. to 31 dols., nail plate at 34 dols., and some other kinds of imported material at some very high figures. The effect of this advance has been to retard operations that would have been pushed through but for the change in prices. The American market has been very strong, and no reaction is within the limit of possibility for months to come. Several large railroad building enterprises are yet to be heard from, and it is probable that, according to the opinions of brokers here, a great deal of English material will be wanted for summer, fall, and early winter delivery for construction purposes. Large orders will be placed this year, unless makers of steel should put on a tariff in the way of quotations. Our advances to-day from Pittsburg and some further Western towns, indicate a very firm condition of the market, and a great many inquiries are under consideration, though the makers are asking for time, and arguing that nothing is to be gained by placing orders so far ahead. All kinds of pig iron are very firm and high in price. Very little material is being offered, simply because there is nothing to sell. Stocks have gone very low, and buyers are able to keep only moderate stock on hand. Some English Bessemer has been sold here at 21 dols., though 21.50 dols. is asked, and sales for the week are estimated at 12,000 tons. The market throughout the Western States is following the Eastern, especially as regards all kinds of merchant steel. The distribution of agricultural productions has stimulated the demand for merchant steel. Demand for railway material, rolling stock, bridge building, and machinery of all kinds, has already set in during the past fortnight, and the probabilities are that the first quarter of the year will be a most active one, because of the movement that has been made to quote prices of all kinds of material from 10 to 20 per cent. higher. Small buyers will be obliged to stand the advance, though large consumers will perhaps defer buying until after the present rush is past. A great many new iron and steel establishments are being erected. Two 100-ton furnaces are being built at Birmingham, Ala., by the Sloss Iron and Steel Company at a cost of 2,000,000 dols. Large steel plants are to be erected in Pennsylvania, and the rolling capacity in Pennsylvania and Ohio mills is to be increased between this and April 1st. The production of anthracite coal reached 32,000,000 tons during the past year. The capacity is 45,000,000 tons. The entire situation is full of interest. Rail buyers have been taken by surprise. Possibly under a high pressure three-fourths of a million tons could be made and sold this year, in addition to supplies already contracted for. A good many conservative authorities are positive of such a boom in the iron and steel industries as will let in large quantities of foreign material. This is probable, although the danger from the standpoint of the American manufacturer is not immediate. The alarm has already been sounded, and both makers and consumers, who, to a certain extent, are interested in the preservation of high value, are endeavouring to steady values. Quotations for old rails are 25 dols. to 25.50 dols.; No. 1 foundry, 20 dols. to 21.50 dols.; No. 2, 18.50 dols. to 20 dols.; forge iron, 16 dols. to 18.50 dols.; nail, 2.10 dols. to 2.30 dols.; plate iron, 2¼ cents per pound. The American Iron and Steel Association warn the iron public against any further advance.

ROYAL METEOROLOGICAL SOCIETY.

THE monthly meeting of this Society was held on Wednesday evening, the 19th inst., at the Institution of Civil Engineers, 25, Great George-street, Westminster; Mr. W. Ellis, F.R.A.S., President, in the chair. Mr. J. Willis Bund was elected a Fellow of the Society. The following papers were read:

1. "*On the Identity of Cloud Forms all over the World; and on the General Principles by which their Indications must be Read*," by the Hon. R. Abercromby, F.R. Met. Soc. The author illustrated the fact of the identity of cloud forms by exhibiting thirty-seven photographs of different kinds of clouds which he had taken in various longitudes and in latitudes ranging from 72 deg. N. to 55 deg. S., including some actually on the equator. Cumulus was shown to be the commonest cloud in the tropics; cumulo-status and cirro-stratus in the temperate zone; and stratus and fog in the Arctic Regions. The author considers that 90 per cent. of the skies all over the world might be described by the seven well-known types of cloud: Cumulus, stratus, cirrus, cirro-stratus, cirro-cumulus, cumulo-stratus, and nimbus; if by cirro-cumulus fleecy-looking clouds are denoted. Although the forms are alike, the prognostic value of the same shape of cloud is not identical everywhere, for while woolly clouds indicate fine weather in England, they denote rain in Italy. The author showed that the form alone of clouds is equivocal; and that the indications of coming weather must be drawn not only from the form, but also from the surroundings of a cloud, just as the meaning of many words can only be judged by the context.

This paper was rendered most interesting by the photographs being thrown on the screen by Mr. B. C. Wainwright, F.R. Met. Soc., from a limelight lantern.

2. "*On the Cloud to which the Name 'Roll-Cumulus' has been applied*," by the Hon. R. Abercromby, F.R. Met. Soc. The author thinks that this cloud should be reported as "stratus" or "cumulo-stratus" according as the component masses partake more or less of the character of one or other of these clouds.

After the reading of these papers, the annual general meeting was held, when the report of the Council was read by Dr. Tripe, which showed the Society to be in a satisfactory condition. The number of Fellows was 524.

PRESIDENT'S ADDRESS.

The President, Mr. W. Ellis, in his address, drew attention to the remarks made by Mr. Hawksley at the meeting of the Royal Meteorological Society on June 16 last, in which, after acknowledging the indebtedness of engineers to meteorologists for the information collected by them concerning floods and rainfall, without which, as he said, it would not be possible for engineers to carry on their work efficiently, proceeded to urge on meteorologists the need of more investigation into the causes of the various phenomena connected with their science. The President suggested that this is just what meteorologists were always endeavouring to do, pointing out how great an amount of labour had already been thus expended, if not always wisely, at any rate with every desire to trace out connections and causes, any want of success being due rather to the difficulties of meteorological inquiry than to any other cause. Referring, then, to the connection of the physical sciences, and especially those of astronomy, terrestrial magnetism, and meteorology, he drew attention to various contrasts and relations existing between them, mentioning how, in astronomy, strict mathematical processes may be employed, whilst in meteorology tentative methods have, to a great extent, to be relied on, a state of development through which astronomy itself had in earlier ages also to pass, giving hope that in the confessedly difficult subject of meteorology, we may in time pass from present systems to others more logical. There has already been progress; the preparation of a daily synoptic weather chart, made practicable by the aid of the electric telegraph, would have been impossible not so very many years ago. Again, in astronomy the power of assimilating observations, as it were, is mostly in advance of the observational power, rendering even greater instrumental means desirable. Not so in meteorology, for the purposes of which instruments can be constructed, with accuracy, beyond the power of adequately employing them, of which the difficulty of ascertaining the true temperature of the air is an illustration. This, indeed, troubles also the astronomer, the element of air temperature being one that enters into the calculation of astronomical refraction, besides which he has in various other ways to reckon with temperature effects. After referring to some popular notions on weather changes as related to the sun and moon, as well as to more systematic endeavours made to discover relations, in general insignificant, between position and periods of the moon and different meteorological elements, the President remarked that the modern meteorologist had happily found a wider sphere of work, for troubling himself less about cycles and periods he has seen the necessity of studying, by the aid of synoptic charts, the complex and broad phenomena of the atmosphere in all their varied relations. Passing on to consider some relations between meteorology and terrestrial magnetism, he mentioned some analogies existing between the meteorological element of temperature, and the motion of the magnetic needle, as regards their diurnal and yearly variations; proceeding

then to discuss to some extent the relation between solar spots, terrestrial magnetism and meteorology, pointing out that whilst in certain broad features the relation with magnetism was very striking, that with meteorology, so far as we are able to interpret the results obtained, is comparatively uncertain. Some allusion was made also to earth currents as related to magnetic phenomena. Before concluding, the President, viewing the present outlook as regards meteorology, spoke of the new and higher meteorology that in spite of the difficulties of the subject, is now springing up. He referred to the various international congresses as having promoted uniformity of action and division of labour, and said that meteorology now, perhaps more than ever, stood in need of combined action among its workers. He also alluded to the idea of federation of which of late so much has been heard, and suggested that a permanent federation of the meteorologists of different countries might regulate meteorological action and inquiry throughout the world, and so promote the better elucidation of meteorological laws, whilst also accumulating materials for the future discussion not only of the meteorology of the earth as a whole, but also of any periodical or secular changes however produced, that might be proceeding thereon.

The following were elected the officers and council for the ensuing year:

President: William Ellis, F.R.A.S. Vice-presidents: George Chatterton, M.A., M.Inst. C.E.; Charles Harding; Cuthbert Edgar Peek, M.A., F.R.A.S., F.R.G.S.; George Mathews Whipple, B.Sc., F.R.A.S. Treasurer: Henry Perigal, F.R.A.S., F.R.M.S. Trustees: Hon. Francis Albert Rollo Russell, M.A.; Stephen William Silver, F.R.G.S. Secretaries: George James Symons, F.R.S.; John Wm. Tripe, M.D., M.R.C.P.Ed. Foreign Secretary: Robert Henry Scott, M.A., F.R.S., F.G.S. Council: Hon. Ralph Abercromby, Edmund Douglas Archibald, M.A.; Francis Campbell Bayard, LL.M.; William Morris Beaufort, F.R.A.S., F.R.G.S.; Arthur Brewin, Frederic William Cory, M.R.C.S.; Henry Storks Eaton, M.A.; Richard Inwards, F.R.A.S.; Baldwin Latham, M. Inst. C.E., F.G.S; William Marcet, M.D., F.R.S., F.C.S.; Edward Mawley, F.R.H.S.; Charles Theodore Williams, M.A., M.D., F.R.C.P.

THE PHYSICAL SOCIETY.

At the meeting of the Physical Society, held on January 22, Professor McLeod, vice-president, in the chair, Dr. F. Wormack was elected a member of the Society. The following papers were then read:

"*The Permanent and Temporary Effects on some of the Physical Properties of Iron Produced by Raising the Temperature to* 100 *deg. Cent.*" by Mr. Herbert Tomlinson, B.A. The paper is divided into three sections: (1) Internal Friction of Iron; (2) The Longitudinal Torsional Elasticities of Iron; and (3) the Velocity of Sound in Iron.

In his experiments on the internal friction of metals, the author uses a vertically suspended wire rigidly clamped at its upper extremity, and having its lower end secured to a horizontal bar of metal, attached to which are two cylinders of equal mass and dimensions, placed at equal distances from the wire. When the system is set in torsional oscillation, the amplitude gradually diminishes, due to the internal friction of the metal and the friction of the air. The combined effect is measured by the logarithmic decrement of the oscillations, while the air effect is eliminated by Professor Stokes' formulæ and the author's experimental determination of the viscosity of air. When the deformations are sufficiently small, the experiments prove that the logarithmic decrement of arc is independent of the amplitude and period of vibration. These results are only true when the wire has been allowed to rest a considerable time after any change has been made in the arrangement, and when there have been a large number of oscillations executed previous to the actual testing.

Reference is made to some experiments by Professor G. Wiedemann, which show that when a wire is subjected to torsional stress, it does not recover itself when the stress is gradually reduced to zero, but remains permanently twisted through a small angle (say θ). By reversing the twisting couple there is a permanent set on the other side of the initial position. If the operations be repeated θ diminishes and attains a minimum. The period during which this diminution takes place is called the "accommodation period."

When a wire is in torsional vibration, the position of equilibrium is continually shifting to and fro, through twice the above minimum angle, and Wiedemann considers the loss of energy due to this shifting.

The author's experiments verify Wiedemann's results, and also show that time and temperature have great effect on the internal friction. By repeatedly heating to 150 deg. Cent., and slowly cooling an annealed iron wire for six days. the logarithmic decrement due to internal friction was reduced to about one-eighth its original amount, at the same temperature, and when the wire was maintained at 98 deg. Cent. the decrement was reduced to one-thirtieth.

The author considers the permanent diminution produced by heating and cooling to be mainly due to the slow shifting backwards and forwards of the molecules, induced by that process.

In the second part of the paper it is shown that the effects of change of temperature on the longitudinal and torsional elasticities of iron and steel, are not nearly so great as that produced on the internal friction. Thus by heating annealed iron wire its longitudinal and torsional elasticities are slightly decreased, but on cooling there is a permanent increase in both. Time is also an important element, for a long rest after cooling still further increases both elasticities.

From the above results it is evident that the velocity of sound in iron and steel must diminish with rise of temperature. This was experimentally proved before the meeting. Attention was particularly directed to this fact, because most of the best text-books make the opposite and erroneous statement. Remarks were made by Mr. C. V. Boys, and the chairman mentioned a new form of clock whose action depends on torsional elasticity of a steel wire.

"*On some New Measuring Instruments used in Testing Materials*," by Professor W. C. Unwin, F.R.S. In most measuring instruments previously used it has been considered sufficient to make the measurement of elongation from one side of the bar, but this, the professor showed, was liable to serious errors owing to the fact that test bars are not always perfectly straight, and to the possibility of originally straight bars being bent by improper fixing in the testing machine. In such cases the moduli of elasticity calculated from the apparent elongation are subject to considerable error. In endeavouring to overcome these difficulties the author has devised several new forms of measuring apparatus, which are attached to two sides of the bar by steel points, and the mean elongation of the two sides determined. The first apparatus described consists essentially of sliding callipers read by microscopes to $\frac{1}{10,000}$ in. Another form has two clamps provided with sensitive levels. Each is attached to the bar by two steel points, lying on a line which is perpendicular to the direction of the stress, and the clamp can rotate in a vertical plane about this line as an axis. The lower clamp is levelled by a screw pressing against the surface of the bar and the upper one by means of a micrometer screw parallel to the axis of the bar, the nut of which is secured to the bottom clamp. By this means the elongation can be measured to $\frac{1}{10,000}$ in. In a third form two similar clamps without levels are kept apart by a steel rod ending in knife edges. One of the clamps carries a small roller, which turns about an axis parallel to the line joining the steel points above mentioned, and the axis carries a small plane mirror. The other clamp supports a projecting arm parallel with the axis of the test piece, and which presses on the surface of the roller. When the bar is elongated the mirror is turned through a small angle, and the elongation is determined by a reading telescope and vertical scale to $\frac{1}{100,000}$ in. A similar apparatus is used for testing the compression of stone, but in this the compression is multiplied by a lever and measured by a micrometer microscope to $\frac{1}{100,000}$ in.

Mr. C. V. Boys directed attention to some beautiful photographs of the solar spectrum just received from the John Hopkins University, which had been obtained by Professor Rowland's concave gratings.

At the conclusion of the meeting Professor Unwin invited the members to visit the engineering laboratory of the City and Guilds of London Central Institution, where he broke a bar of Staffordshire iron in the 100-ton testing machine, the force and elongation being automatically recorded.

LAUNCHES AND TRIAL TRIPS.

On Friday, 21st January, Mr. W. S. Cumming, of Blackhill Dock, near Glasgow, launched a steel lighter named the Jane, and measuring 66 ft. by 13 ft. 6 in. by 5 ft. Built to the order of Mr. Robert Bain, of Glasgow, and intended for the general trade on the Forth and Clyde and Monkland canals, she is the first steel vessel constructed for that trade.

On the following day, Messrs. David J. Dunlop and Co., Inch Works, Port-Glasgow, launched a combined twin-screw steel hopper dredger, which has been built for the Bombay Port Trust, and to the order of Mr. James A. M'Connochie, London, under whose superintendence she has been constructed. She measures 155 ft. by 31 ft. by 10 ft. The hopper has a capacity under deck of 10,000 cubic feet, and she has a displacement available for carrying 500 tons deadweight in the shape of spoil on a draught of 3 ft. of water. The dipper dredgers, one of which is fitted to each compartment, have been supplied by Messrs. Stothert and Pitt (Limited), of Bath. They are capable of loading the hopper in two hours and can be worked close up to the quay walls. The Pholas, the name by which the vessel is to be known, is provided with one of Messrs. Shand, Mason, and Co.'s most powerful fire engines, while in connection with the main engines there is a centrifugal pump which may be used for salvage purposes. The propulsion of the vessel will be effected by means of a set of twin-screw compound surface-condensing engines of 350 indicated horse-power collectively, and all the most modern appliances have been adopted for working the vessel.

Also on 22nd January, Messrs. D. and W. Henderson and Co., Meadowside, Partick, Glasgow, launched the Bellaura, a steel screw steamer of 2800 tons gross register, and having a carrying capacity of about 4000 tons. She has been built to the order of Messrs. Bell Brothers and M'Lelland, Glasgow, and is intended for the general carrying trade; she measures 310 ft. by 39 ft. by 25 ft. 6 in., and will be fitted by the builders with triple-expansion engines of 1300 horse-power and working with a steam pressure of 160 lb. per square inch. Her other machinery will include steam steering gear by Messrs. Muir and Caldwell and Napier Brothers' direct-acting windlass. Messrs. Henderson and Co. have two similar steamers building on the stocks for the same firm.

Messrs. Ramage and Ferguson, Leith, on Monday, 24th January, launched an iron steam yacht named the Rondine (Italian for swallow), which has been built to the order of Prince Scrignano, of Naples. Designed as a first-class ocean cruiser, having a raking cutwater, with square stern and rigged as a three-masted schooner with yards on the foremast, she measures 192 ft. by 26 ft. 6 in. by 16 ft. 6 in., and her tonnage is about 620 yacht measurement. She is to be of great speed and is to be fitted by the builders with triple-expansion engines of the latest type, the cylinders being 19 in., 31 in., and 49 in. in diameter, respectively, with a piston stroke of 31 in. Steam of 150 lb. pressure will be supplied by two steel boilers fitted with Fox's corrugated furnaces. These engines are estimated to drive the yacht at a speed of 13 knots, or about 15 statute miles, per hour. The accommodation and fittings throughout are to be of a very complete and even luxurious character.

On Monday, the 24th inst., there was launched from the yard of the Sunderland Shipbuilding Company, Limited, an iron screw steamer of the following particulars: Length between perpendiculars, 165 ft.; breadth, 24 ft. 6 in.; depth of hold, 12 ft. 6 in. The machinery is by Messrs. Thomas Clark and Co., of Newcastle, having cylinders 21 in. and 42 in. in diameter by 27 in. stroke, with a large steel boiler working at a pressure of 100 lb. per square inch. On leaving the ways the vessel was named Kinyomaru by Miss Newton, of Shields. This vessel has been built to the order of Messrs. Leech, Harrison, and Forwood, of Liverpool and London.

On Tuesday, January 25, Messrs. Robert Duncan and Co., Port-Glasgow, launched an awning deck steel screw steamer, named the Hondo, a vessel of 1615 tons gross register, and measuring 236 ft. by 35 ft. by 19 ft. She has been built to the order of the Honduras and Central American Steamship Company, for their passenger and fruit trade between Central America and New York. Messrs. Muir and Houston, Glasgow, are supplying the Hondo with triple-expansion engines having cylinders of 22 in., 35½ in., and 57 in. in diameter respectively, and the piston stroke being 39 in. Steam of 160 lb. pressure will be provided by two steel boilers, each 13 ft. 6 in. by 10 ft. 6 in.

With the same tide, Messrs. A. and J. Inglis, Pointhouse, Glasgow, launched the Thames, a screw steamer of 890 tons gross, and measuring 230 ft. by 31 ft. by 16 ft. 9 in. Owned by the Carron Company, and a sister ship to the Forth, which was launched from the same yard last November, the Thames is intended for a new passenger trade between Grangemouth and London. She is to be fitted by the builders with triple-expansion engines of 2200 horse-power.

At the close of last week there proceeded to sea from the Middlesbrough Docks the s.s. Santiago, which has been built by Messrs. Raylton, Dixon, and Co. to the order of Messrs. Thomas Wilson, Sons, and Co., of Hull, for their trade from Hull to New York. This vessel is the largest and most powerful boat yet built on the Tees, and is a very handsome model. She is built of steel, with cast-steel sternpost and rudder, and is of the following dimensions: 378 ft. long, 44 ft. 9 in. beam, by 31 ft. depth. Her deadweight carrying capacity is over 5500 tons. She has a cellular double bottom for water ballast, two decks of steel, and twelve bulkheads, as well as longitudinal iron bulkheads, all fore and aft. She is fitted with engines by Messrs. Thomas Richardson and Sons, of Hartlepool, having cylinders 31 in., 49 in., and 80 in. by 54 in. stroke, which indicate over 3500 horse-power, and developed a speed of 13⅜ knots on her half-loaded trial trip; they will maintain 12½ knots in actual service.

On Wednesday, January 26, there was launched from the shipbuilding yard of Messrs. Edward Finch and Co., Limited, into the Wye at Chepstow, an iron twin-screw tug and salvage steamer, built to the order of Sir William Thomas Lewis, for the Bute Dock Estate, Cardiff. On leaving the ways she was gracefully christened The Earl by Miss Rowe. The vessel was immediately towed to the builders' fitting-out wharf, where, from the new 70-ton sheers, she will receive her boiler—some 13 ft. in diameter by 11 ft. long—and twin engines of 500 indicated horse-power; also centrifugal salvage pump equal to 200,000 gallons per hour; also with a fire pump 21 in. steam cylinder, 14 in. bucket, 3 ft. stroke, capable of throwing about 100,000 gallons per hour to a vertical height of 180 ft., for the efficient protection of the warehouses, shipping, and other property on the estate. This is one of the most powerful fire pumps extant, and in capacity commensurate with the vast range of property it is intended to cover.

The Institution of Civil Engineers.—In advance of the general issue, next month, of vol. lxxxvii. of the Minutes of Proceedings, there have lately been put in circulation, in pamphlet form, the six papers on "Concrete Work for Harbours," with the relative discussion and correspondence to which they gave rise last November, and also a paper on "The Electric Lighthouses of Macquarie and of Tino," which formed the subject of debate in December.

Cook's River.—Plans which have been prepared by the New South Wales engineer-in-chief for harbours and rivers for the improvement of Cook's River show that a basin at the dam is to be 24 chains, or 1584 ft. long, and 450 ft. wide. Shea's Creek, which runs into the river, is to be dredged out to 100 ft. in width, the river channel to M'Crea's Point is to be 400 ft. wide, and from this point to the deep waters of Botany Bay it is to be 300 ft. wide. The flats which will be improved in this manner are understood to be Crown land, and it is proposed to let them out as market gardens.

STATIONS ON THE EASTERN AND MIDLANDS RAILWAY; CROMER EXTENSION.

MR. WILLIAM MARRIOTT, ENGINEER.

THE EASTERN AND MIDLANDS RAILWAY EXTENSION TO CROMER.

(*Concluded from page* 58.)

To complete the description we have published in previous issues of the works upon the Eastern and Midlands Railway Cromer extension, we publish above engravings of two of the stations upon the line, which will serve to illustrate their general design and arrangement. In the West Runton Station an upper floor is provided for the use of the railway officials, over one wing of the building. The Holt Station has only one floor and is a good example of commodious arrangement for a minor station on a country line. Although it will be seen that the Cromer Extension Railway offers no works of any great importance, the engineer, Mr. Marriott, has bestowed much skill in designing such works as were required with a view of their suitability and economy, and we think that the publication of so complete a series of type drawings will be found of value and interest to our readers.

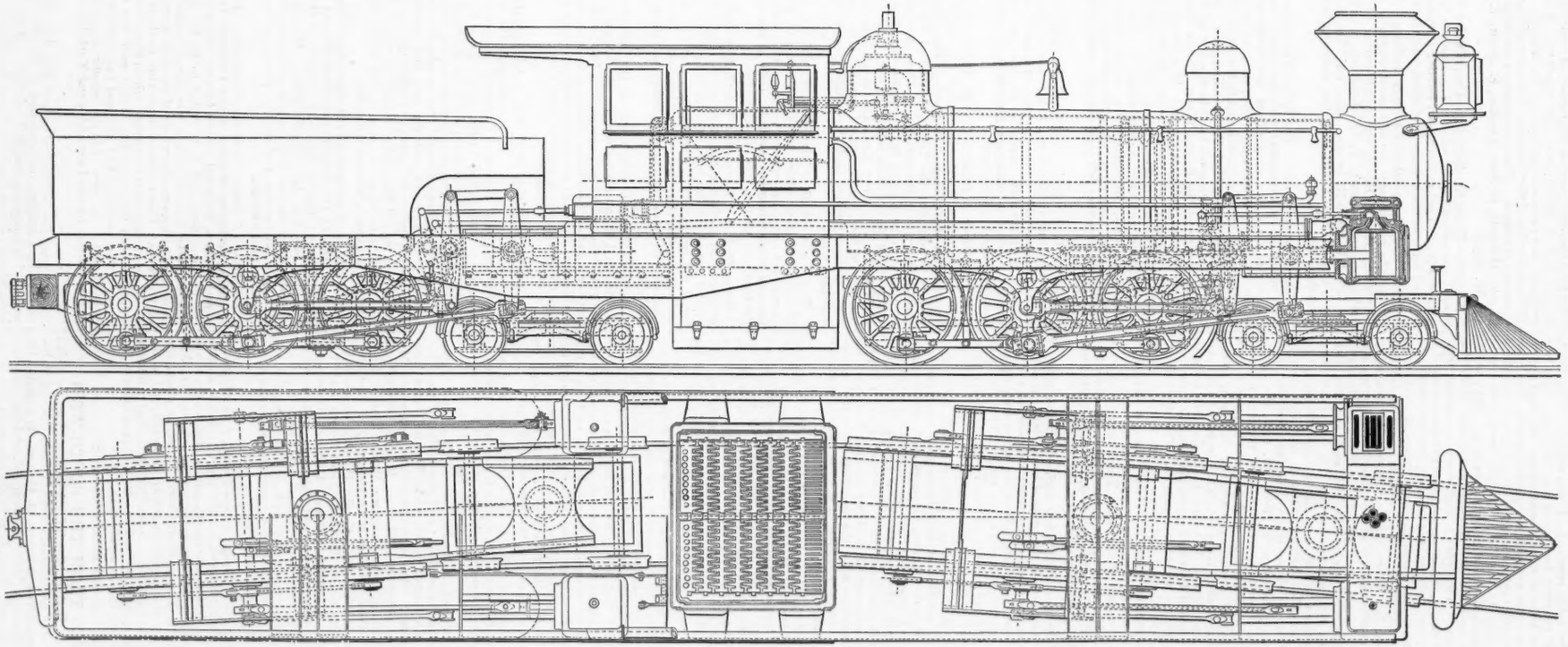
THE YARRA.—Improvements effected in the Yarra during the past twelve months have so increased the facilities for the discharge of cargo that there were recently thirty-three ocean-going vessels lying at Melbourne wharves. A large proportion of the vessels would, as matters formerly stood, have had to obtain berths at Port Melbourne.

THE SPANISH NAVY.—The measure for reinforcing the Spanish Navy, which was introduced into the Cortes by the late Minister of Marine, Admiral Béranger, and which was adjourned after a long discussion, has just been published. Premising that the fleet at present comprises only two ironclads of the line, the Victoria and the Numancia, and a dozen third-class cruisers, Admiral Béranger proposed that a sum of 9,000,000*l.* should be spent upon the Navy during a period not to exceed nine years, and that of this sum 500,000*l.* should go to completing the submarine coast defences, 400,000*l.* to enlarging the arsenals, and 900,000*l.* to finishing the vessels now in course of construction, which include four first-class cruisers, seven torpedo cruisers of different types, and a turret-ship. With the remaining 7,200,000*l.*, Admiral Béranger proposed to build eleven ironclad cruisers—three of 4500 and eight of 3200 tons, with a speed of from 19 to 21 knots an hour; six second-class torpedo cruisers, with a speed of from 21 to 23 knots; four torpedo cruisers, with a speed of from 18 to 21 knots; 96 first-class torpedo boats, with a minimum speed of 24 knots; 12 steel gunboats; 16 torpedo gunboats; and 20 steam vessels built upon the model of lifeboats. When this project has been carried into execution, the Spanish Navy will consist of three ironclads, 15 cruisers of the first-class, 18 of the second, 17 torpedo cruisers, 100 torpedo boats of the first-class, 16 gunboats, and 20 small steamboats.

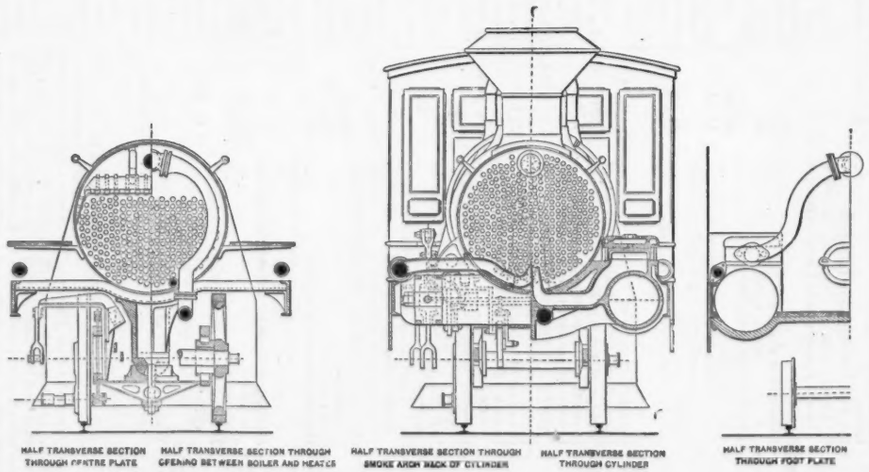
THE BATH AND WEST OF ENGLAND SOCIETY AND ITS SECRETARY.—At the council meeting at the Bath and West of England Society held at Bristol on the 25th inst., a communication was submitted by the secretary, asking if the Council would sanction his offering himself as a candidate for the secretaryship of the Royal Agricultural Society of England now vacant. On the motion of the Right Hon. Sir T. D. Acland, Bart., seconded by Colonel Luttrell, the following resolution was unanimously passed: "That the Council, though they regret losing Mr. Plowman's services, cannot refuse their consent to his candidature, and that a committee, consisting of Sir R. H. Paget, Bart., M.P., Mr. Acland, M.P., and Mr. H. P. Jones, be appointed to draw up a letter of recommendation expressing the high opinion which the Council entertain of his services." The above-named committee shortly afterwards submitted the following letter, which was unanimously accepted, and was signed by Sir J. T. B. Duckworth, Bart., as chairman: "The Council of the Bath and West of England Society and Southern Counties' Association have great pleasure in giving their unanimous testimony to the unflagging zeal and the very thorough efficiency of the services rendered to them by Mr. Thos. F. Plowman in every department of the duties entrusted to him. Mr. Plowman came to the Society with the very highest recommendations, from many quarters, based upon experience of his capacity in various forms of service in similar posts held by him, and this Council have, on the present occasion, no hesitation in stating that he has fully realised the high expectations they had grounded on the character of those recommendations. Should his candidature be successful the Council, while sincerely regretting the loss of so good an officer, will feel that the Royal Agricultural Society of England has secured a very valuable servant."

FOUR-CYLINDER LOCOMOTIVE FOR THE MEXICAN CENTRAL RAILWAY.

CONSTRUCTED FROM THE DESIGNS OF MR. F. W. JOHNSTONE, LOCOMOTIVE SUPERINTENDENT.



WE reproduce from the *National Car and Locomotive Builder* the annexed engravings of a locomotive, designed by Mr. F. W. Johnstone, superintendent of motive power of the Mexican Central Railway, for pulling trains over the steep mountain grades on the Gulf and Pacific branches of the road. Of this engine our contemporary says: "It is a new departure in locomotive design, the weight of the tender being utilised for the purpose of giving adhesion to driving wheels placed under it. An ordinary four-wheel truck is placed under the smokebox, and another under the deck, these secondary trucks being pivotted in the ordinary way, but the centre pin, instead of being attached to a rigid frame, is attached to the driving wheel truck frame, which is itself pivotted at a centre bearing. Both engine and tender are carried upon the same rigid frame, but a marked peculiarity and divergence from previous methods is, that while the cylinders are attached to the main frame, the groups of wheels to which they impart motion are carried by a separate and swivelling frame, so that on curved portions of track the longitudinal axes of the cylinders and the truck frames are parallel. In order to allow for the angle between the plane of motion of the crank-pin and the longitudinal axis of the piston-rod, consequent upon this arrangement, the strap ends of the forward ends of the main connecting and tension-rods are pivotally connected to the brasses, so as to allow of a horizontal vibration, while at the same time the brasses may be filed or keyed up without affecting this movement of the rods. An arrangement of a similar character is applied to the eccentric rods for the same purpose.


HALF TRANSVERSE SECTION THROUGH CENTRE PLATE
HALF TRANSVERSE SECTION THROUGH OPENING BETWEEN BOILER AND HEATER
HALF TRANSVERSE SECTION THROUGH SMOKE ARCH BACK OF CYLINDER
HALF TRANSVERSE SECTION THROUGH CYLINDER
HALF TRANSVERSE SECTION THROUGH FOOT PLATE

"The piston-rod crossheads are not connected directly to the crank-pins by connecting-rods, but act through an intermediary system of levers, which not only allows of the swivelling of the truck frames without interfering with the transmission of power, but also permits a crank-pin stroke greater than that of the pistons, and consequently a reduced piston speed relatively to a given speed of the driving wheels. The crossheads carry pivotted to them vertical rocking levers, to the lower extremities of which are attached connecting-rods leading to the crank-pins of the centre pair of wheels which they drive. The upper extremities are connected with the corresponding extremities of similar levers of equal size oscillating on journals in boxes attached to the main frame, and placed but a short distance from the crosshead levers, with the centres on the same horizontal axis as these. To the lower extremities of these secondary levers are attached tension rods, which, at their other ends are fastened to pins on the truck frame, so that as the points of attachment to the truck frame move back or forward as the truck swivels on the curves, the forward end of the main connecting-rod is moved to a corresponding extent by means of the crosshead lever.

"The driving wheels under the tender are driven in a similar way, the power being transmitted from cylinders bolted to a casting which forms the foot-plate.

"The boiler is of the ordinary straight type, but the firebox being between the two truck frames is not restricted in width. In regard to this form of engine Mr. Johnstone writes us: 'I am now making drawings of an engine embodying these principles, but with only two

cylinders and six wheels connected, and two four-wheel trucks under the tank. I wish to try and introduce this lighter engine for freight and heavy passenger service, as it is more generally adapted for all roads having heavy traffic than the larger engine.

"'The main object obtained in this design is a very large firebox, which is suspended without overhanging. The firebox of the engine I am now designing will be 6 ft. long and 8 ft. wide, cylinders 22 in. by 18 in., which is equal to 19 in. by 24 in. With so large a firebox very large nozzles can be used and no netting will be necessary.'

"The leading dimensions of the engine illustrated are:

Weight and General Dimensions:	
Gauge of road	4 ft. 8½ in.
Total weight of locomotive in working order	185,000 lb.
Total weight on driving wheels ...	140,000 ,,
,, wheel base	52 ft. 1 in.
Distance between centres of drivers ...	5 ,, 0 ,,
,, ,, cylinders...	7 ,, 6 ,,
Cylinders, Valves, &c.:	
	in. in.
Diameter of cylinders and stroke of piston	22×18
Stroke of crank-pin on drivers... ...	36
Size of steam ports	16× 1½
,, exhaust ports	16× 2½
Greatest travel of slide valves	5½
Outside lap	1⅛
Inside ,, ...	1/16
Lead of slide valves in full stroke ..	1/16
Sectional area of opening in each steam pipe connected with cylinders	19½ sq. in.
Wheels:	in. in.
Diameter of drivers	57
,, truck wheels	28
Size of driving axle journals	7 ×8
,, truck ,, ,, ...	4½×8
,, main crank-pin journals ...	4½×4½
,, coupling-rod journal on main pins	4⅞×3½
Other coupling-rod pin journals ...	3½×3½
Boiler:	
Description of boiler	Straight
Inside diameter of smallest boiler ring	63 in.
Number of tubes in boiler	304
Diameter of tubes in boiler outside ...	2¼ in.
Length of tubes in boiler over tube-plates	12 ft. 1 in.
Number of tubes in heater	388
Diameter of tubes in heater outside ...	2¼ in.
Length of tubes in heater over tube-plates	6 ft. 3 in.
Distance between centres of tubes in boiler	2⅞
Distance between centres of tubes in heater	2⅞
Size of firebox inside, length × width × depth from underside of crown plate to bottom of mud ring... ...	72 in. × 84 in. × 82 in.
Maximum working steam pressure per square inch	140 lb.
Grate surface	42 sq. ft.
Heating surface in firebox	204 ,,
,, ,, of the inside of tubes in boiler	1946 ,,
Heating surface of the inside of tubes in heater...	1292 ,,
Total heating surface	3442 ,,
Height from top of rails to top of chimney...	14 ft. 6 in.
Tank:	
Water capacity of tank in gallons ...	4000
Coal capacity	12,000 lb.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—There was a slight buoyancy at the opening of the warrant market last Thursday, on rumours that the Lanarkshire colliers were out, and that the refusal of the coalmasters to concede the advance of wages asked would likely lead to a big strike. The consequence was that prices went up all round, but speculative holders, taking advantage of the rise, began to sell, and there was a relapse. At one time during the forenoon Scotch warrants were up at 47s. 1d. cash per ton, but the close in the afternoon was 46s. 8½d. cash buyers, or 1d. per ton under the previous day's closing quotations, and 5d. per ton under those of last Friday. Cleveland warrants again touched 39s., but closed at 38s. 7½d. Hematite was very active and strong, and the price was run up to 51s. 9d. cash, the highest quotation then reached, and to 52s. 1½d. one month, but the close was slightly under those rates. Friday's warrant market opened very strong, and it seemed as if there was going to be another "boom," especially in hematite pig iron, but a rather severe reaction took place, and prices came toppling down to a level considerably under that of the previous day's close. Hematite pig iron started at an advance of 2½d. per ton and got up to 52s. 1½d. cash and 52s. 6d. one month, but at the close the prices had fallen to 51s. cash and 51s. 4½d. one month, being a drop of 1s. 1½d. per ton from the highest price during the day. Scotch warrants also showed some firmness in the morning in sympathy with hematite, but the price afterwards fell from 46s. 10½d. to 46s. 2½d. cash, and closed at 46s. 6d., being only 2½d. under the previous day's close, but 7½d. per ton down on the week. Some excitement was manifested on Monday, but it was chiefly over a falling market. Business started with holders firm, but the political news made buyers cautious, and the subsequent announcement of a great falling off in the week's shipments of pig iron was somewhat unfavourably received. Prices came severely down, but a slight recovery took place near the close owing to a rumour that the coal miners' conference, held that day in Glasgow, was sure to result in a general strike. The price of Scotch warrant iron opened at 46s. 7½d. cash, but there was a decline to 45s. 7d., followed by a recovery to 45s. 10½d. cash, the close being buyers at 45s. 10d., or 8d. under last week's close. Hematite warrants closed 4d. per ton down. Yesterday's market was somewhat irregular, and prices, which opened firm in expectation of a general strike amongst the miners, became weak, as reports came to hand that the men were still working in some of the mining districts. Scotch warrants declined 4d. per ton, but there was a recovery in sympathy with the improved tone of the Stock Exchange, and the market closed with prices the same as Monday's closing quotations—buyers 45s. 10d. cash and 46s. 1½d. one month, and sellers wanting 1d. more per ton. Scotch warrants exhibited a little more strength this forenoon, but the prices fluctuated, and the close in the afternoon was buyers at 45s. 7½d. cash and 45s. 10½d. one month, with sellers at 45s. 8½d. and 45s. 11½d. respectively. Last week's shipments of pig iron from all Scotch ports amounted to 4962 tons, as compared with 9215 tons in the preceding week, and 6051 tons in the corresponding week of last year. They included 1135 tons to the United States, 150 tons to India, 115 tons to Australia, &c., 621 tons to France, 200 tons to Italy, and smaller quantities to other countries. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores yesterday afternoon stood at 841,959 tons, as compared with 841,341 tons yesterday week, thus showing an increase over the week of 618 tons. There are now blowing in Scotland 76 furnaces, as against 94 at this time last year—16 making hematite pig iron, 7 making basic iron, and 53 making ordinary iron.

Further Increase in the Price of Steel.—In consequence of the further advances in the price of hematite pig iron, the Scotch steelmakers held a conference after the close of the warrant market last Friday afternoon, when they agreed to raise the price of steel 5s. per ton. The rates now for fresh orders are: Boiler plates, 7*l.* 10s. per ton; ship-plates, 7*l.* 5s.; angle bars, 6*l.* 5s. per ton.

Institution of Engineers and Shipbuilders in Scotland.—An ordinary meeting of this Institution was held last night—Mr. Robert Dundas, vice-president, in the chair. The principal item of business was the reading of a paper by Mr. Hector M'Coll, of Liverpool, on "The Shafting of Screw Steamers." It was of a very comprehensive character, and it is likely to lead to a very interesting discussion after the members have had an opportunity of carefully reading it in type. The importance of the subject is acknowledged on all hands.

The Electric Light on the May Island.—There is good reason to believe that this light—a description of which was recently given in ENGINEERING—has been seen at sea at a distance of 46 miles. The observer is Captain Chedin, of the screw steamer Frithiof, of Gothenburg, which port he left at 2 p.m. last Thursday, and got a beam of the May light on Monday morning at half-past eight o'clock. His course had been made direct for the May.

The Glasgow Tramway System.—In the half-yearly report of the Glasgow Tramway and Omnibus Company (Limited), which has just been issued, it is stated that the length of the system now leased by the company is thirty miles. During last half-year the number of miles run was 2,156,169, being an increase of 96,345 miles over the length run in the corresponding half-year of 1885. The average number of horses and mules in stock during the half-year was 2614. The past half-year's drawings showed a considerable falling-off, a fact which may be taken as indicative of a severe depression in trade.

Watt Anniversary Dinner.—The anniversary of James Watt's natal day was celebrated in Glasgow last Saturday evening by the foremen engineers of the Clyde district, who dined together in the Grand Hotel, Charing Cross. Mr. George Russell, of the Motherwell Crane and Engine Works, occupied the chair; and the duties of the vice-chair were discharged by Mr. John Turnbull, Jun., consulting engineer. Amongst the guests there were: Mr. John Scott, Greenock; Messrs. Robert Duncan and David J. Dunlop, Port-Glasgow; Messrs. James Riley and F. W. Dick, of the Steel Company of Scotland; Messrs. John Ward and F. P. Purvis, Dumbarton; Messrs. T. B. Seath, William Arrol (Forth and Tay Bridges), T. A. Arrol, Robert Dundas, (Caledonian Railway), Mollison (of Lloyd's), Councillors Mechan and Graham, and other well-known gentlemen. Several excellent speeches were delivered in connection with the principal toasts of the evening, and altogether the birth-day celebration was a very great success.

Visit to the Forth Bridge.—Last Saturday the members of the engineering class of Edinburgh University, accompanied by Professor Armstrong, paid a visit to the Forth Bridge works, over which they were shown by Mr. A. S. Biggart. The superstructure already in place, and the mode of erection, were minutely inspected, and at the close of the visit Professor Armstrong, on behalf of himself and his students, expressed his high appreciation of the kindness shown by the contractors.

NOTES FROM THE SOUTH-WEST.

A Pontoon Dock at Cardiff.—A new project, in which shipowners and manufacturers are largely interested, has just been registered at Somerset House. It is styled the Wallsend Pontoon Company, Limited, and the proposed capital is 50,000*l.*, divided into 2000 shares of 25*l.* each. The object of the promoters is to establish at Cardiff an iron floating pontoon dock, and to carry on at Cardiff and elsewhere the businesses of proprietors of docks and warehouses, and of shipbuilders and repairers. Among the parties to the various contracts are the Marquis of Bute, William Boyd, and the Wallsend Slipway and Engineering Company, Limited. The first directors are to be Messrs. Charles Mitchell, R. Sims Donkin, E. Stout, T. Nelson, and W. Boyd.

Newport.—There has been a good inquiry for rails and bars at somewhat higher rates. The iron ore trade has been steady, and prices have been tending upwards. The demand for coal has been good at about late rates.

Cardiff and Monmouthshire Valleys Railway.—A Bill to incorporate a company for the construction of railways connecting Roath, Risca, and neighbouring places with the Brecon and Merthyr Tydvil Junction, the Bute, and the Great Western Railways, came on Thursday before Mr. Campion, who found that the standing orders had been complied with.

Water Supply of Bristol.—The Bristol Consumers' Water Bill, promoted by a company with the view of supplying Bristol with a water supply from the Sudbrook stream on the Monmouth side of the Severn, came on Thursday before Mr. Robinson. The examiner, after hearing arguments, said he would certify that the standing orders had been complied with. Comments have been made on the short-sighted policy of the Bristol Water Works Company in not securing the Sudbrook stream. It is stated, however, that the company was, until recently, in negotiation with the Great Western Railway Company as to the purchase of the stream, and made a conditional offer for its acquisition; but that, after giving the subject careful consideration, and acting on what they deemed competent advice, the directors felt compelled to withdraw from the negotiations.

Cardiff.—Last week's shipments of steam coal were large, exceeding 160,000 tons, but prices experienced no improvement. House coal has been in good demand, and the best qualities have made 8s. 9d. per ton. Manufactured iron and steel rails show a slight improvement. The iron ore trade has been firm.

Water Supply of Plymouth.—The Plymouth Corporation Bill came on Wednesday before Mr. Robinson, for examination of standing order proofs. The object of the Bill is to empower the Town Council of Plymouth to make a reservoir in the parishes of Sheepston and Walkhampton, to be formed by an embankment across the valley of the Meavy at an estimated cost, including lands, of 76,000*l.* The Town Council further seeks power to borrow 100,000*l.* to be repaid within sixty years, &c. The examiner decided that the standing orders had been complied with.

Bristol and South Wales Railway Wagon Company (Limited).—The directors at their meeting on Friday determined to recommend the payment of a dividend for the half-year ending December 31, 1886, at the rate of 10 per cent. per annum, free of income tax.

Barry Dock and Railways.—This Bill, which is being promoted to authorise the payment of interest out of capital during construction in order to facilitate the raising of the remainder of the capital, and for other purposes, came on Friday before Mr. Campion. The examiner was satisfied that the standing orders had been complied with.

Engineer Students.—The Lords of the Admiralty have decided that the number of engineer students to be entered at the training school at Devonport in July shall comprise forty-one engineer students, eleven nominated as service candidates, three as colonial candidates, and not more than three students of naval construction.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Difficulties with Colliers.—Yesterday an understanding was come to with regard to the notices given by the men employed at the East Gawber collieries, by which a strike was averted. The men gave in their notices, which under ordinary circumstances would have expired to-day. The management, however, met the men and agreed to pay them the list prices in respect to which they gave notice, and it was agreed the notices should be allowed to lapse. The relations between the miners and masters at Monk Bretton, appear to be more amicable.

Steel Rails.—A contract for the supplying of 30,000 tons of steel rails to the Manchester, Sheffield, and Lincolnshire Railway Company has been secured by Messrs. C. Cammell and Co., Limited, Sheffield. The rail trade is now very brisk in the district, and prices are advancing. Hematite billets are realising 5*l.* per ton net, a rise of 7s. 6d. in seven weeks.

Relighting of Blast Furnaces.—Yesterday Mr. C. J. Stoddart, managing director of the Parkgate Iron Company, Limited, relighted a blast furnace which had been out for some time, and it is stated to be his intention later on in the week to put into operation a second furnace, thus bringing into use the whole of the blast furnace plant at Parkgate. These signs of improving trade are giving great satisfaction in the district, which has suffered considerably from the depression of the past two or three years. This company has received the contract for the general plates required for the ninety locomotives recently ordered by the Lancashire and Yorkshire Railway Company.

Improvement in Trade.—The past few days have been marked by a striking improvement in all the heavy iron and steel industries of South Yorkshire. Hematite irons have advanced in value from 3s. to 4s. per ton since the

opening of the year, and most of the iron and steel mills are now fully employed. The call for best crucible steel for tool and special purposes is daily becoming heavier, and it is evident that the reaction is an all-round one, as both home and export houses find their order books to be rapidly filling. The engineering houses report business as again assuming a healthy tone, and the majority of their "hands" are now employed full time.

Improvements at Pontefract.—Yesterday, Mr. John Thornhill Harrison, Local Government Board Inspector, held an inquiry at Pontefract, relative to an application made by the Town Council to borrow the sum of 5000*l.* for carrying out additional sewerage works not contemplated in the original scheme of drainage already carried out, for deepening sewers, additional water supply, for street improvements, and other sanitary works. Mr. Harrison held that the whole inquiry was very unsatisfactory, seeing that much of the work had been done without making application to the Local Government Board for sanction to borrow the money.

Trade of the Erewash Valley.—The leading collieries are doing a fair trade with London. Best kinds of Kilburns and deep soft house are quoted from 8s. upwards at the pit mouths. The pig iron trade is brisk, and the tendency of prices is still in an upward direction, foundry pig being now quoted from 35s. to 40s. per ton at the works, and forge pigs being retailed from 33s. to 36s. per ton. The Butterley Company are making considerable alterations, and the new 8-in. and 10-in. mills at the Butterley Works are fast approaching completion. The leading works continue to do a heavy business in mains and pipes.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the attendance on 'Change was smaller, and prices were weaker. Business, however, was steady. For prompt delivery No. 3 Cleveland pig iron was quoted 37s. 3d. per ton, and for delivery over a few months 37s. 9d. was the price. During the past few days the iron markets have been in an unsettled state owing to the political rumours, but the prospects of improved demand are as apparent as ever. From the Continent, and more particularly Germany and Italy, the advices show that prices are advancing for all classes of iron and steel. It is, moveover, a fact that good orders have recently been placed in this district for shipment to these countries. Cablegrams from America continue the satisfactory accounts as to the demand for iron there, and at present there are negotiations going on for further large parcels of pig iron and steel on American account. This month the shipments of pig iron from the Tees are small, there having been exported up to date 31,319 tons as compared with 47,800 tons at this time last month and 36,000 tons at the corresponding period last year. There is still an excellent demand for hematite and prices are firm. Manufactured iron and steel have advanced in price. Ship plates are selling at 5*l.* per ton, angles 4*l.* 10s. to 4*l.* 15s., steel ship plates, 6*l.* 10s., and angles 5*l.* 10s. to 6*l.*, all less 2½ per cent. at works. Steel rails are 4*l.* 10s. per ton f.o.b.

Engineering and Shipbuilding.—Both these industries are more active. There is more general engineering work on hand, and the foundries engaged on railway work are very busy on export orders. Shipbuilding keeps improving. The Tyne presents appearances of considerable briskness. Large firms like Sir William G. Armstrong and Co., Messrs. Hawthorn, Leslie, and Co., and the Palmer Shipbuilding Company, are employing a great number of men. Messrs. John Readhead and Co., of the West Dock Shipbuilding Yard, South Shields, have at present on the stocks two steamers of over 3000 tons burden. Both are for local owners. They have also an order for a steamer of 4000 tons for a London firm. All the vessels are of steel, and will be supplied with triple-expansion engines by the builders. The Palmer Shipbuilding Company launched from their Yard at Jarrow on Saturday a splendid steamer specially built for carrying petroleum in bulk.

The Steel Trade.—The steel trade continues very active, prices are stiffening, and more orders are coming to hand. Upwards of 1000 men employed at Messrs. Bolckow, Vaughan, and Co.'s Eston Steel Works, Middlesbrough, have sent in their notices to terminate their engagements unless they receive an advance of 10 per cent. in their wages. The company are not willing to concede so large an advance, and preparations are being made to close the works at the end of this week. It is, however, hoped that some compromise will be arranged and a stoppage of work prevented.

The Coal and Coke Trades.—Coal is steady and coke is firmer. The threatened stoppage of the collieries in Northumberland is attracting more attention. A ballot has been taken in the different villages, and a large majority of the pitmen are in favour of a strike rather than submit to the reduction of wages as proposed by the coalowners. If the question is not amicably settled in a few days there will be something like 24,000 pitmen idle next week.

MISCELLANEA.

Two hundred and twenty-four miles of telegraph were last year renewed in Upper Burmah, and 159 miles of new line have been constructed.

The floating exhibition proposed for Bordeaux has been abandoned, but the one fitted out at Marseilles, in the "Sarthe," for South America is to be completed.

At the adjourned annual meeting of the Medway Portland Cement Company (Limited), held at the works at Cuxton on Monday, the directors recommended a dividend of 7½ per cent.

A falling off is shown in the combined imports and exports of Swansea of last year, as compared with the previous year, of about 3¼ per cent. in volume.

The *New York Tribune* states that an iron company at Chattanooga has contracted with an English firm for the delivery of 40,000 tons of pig iron for the manufacture of steel rails.

The principal provision of the recent addendum to the Postal Convention of 1876 between Belgium and the United Kingdom, is to the effect that the Belgian Government shall, at its own expense, establish a third daily mail service between Dover and Ostend.

The French Cabinet has decided on accepting the resolution of the Budget Committee for an issue of six-year Treasury bonds to the amount of 167,000,000f.—namely, 86,000,000f. for the army, 26,000,000 f. for the navy, and 55,000,000f. for public works.

The last issue of the Board of Trade Official Journal states that the works in connection with the new dry docks at Sebastopol, have now, with regard to the first dock, been concluded by the blowing up, by a submarine mine, of the framework of piles, 45 ft. below the surface, that acted as a foundation for the temporary breakwater.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended January 16, amounted, on 15,386¾ miles, to 1,033,822*l.*, and for the corresponding period of 1886, on 15,246 miles, to 1,032,720*l.*, an increase of 140¾ miles, or 0.9 per cent. and an increase of 1102*l.*, or 0.1 per cent.

A consignment of different soils from the Egyptian Delta has been sent to the Royal Society by the Royal Engineers in that country. The specimens were obtained from borings carried out to a depth of 200 ft. without reaching bottom. The Royal Society has granted a sum for the continuance of the work by the Royal Engineers.

On Monday, the 17th inst., the s.s. Bakuin arrived at the London and Thames Haven Petroleum Wharf from Batoum at 8.30. She commenced to discharge 735 tons of Russian petroleum oil at 11.30 a.m., and finished at 12 p.m., leaving for the Continent at 3 a.m. on Tuesday. This is the quickest operation of the kind ever done.

The Association of Municipal and Sanitary Engineers and Surveyors notifies that the third examination of candidates for the offices of municipal and local board engineers and surveyors will be held at the Institution of Civil Engineers, Great George-street, S.W., on Friday and Saturday, the 22nd and 23rd of April next.

The usual fortnightly meeting of the Liverpool Engineering Society was held at the Royal Institution, Colquitt-street, Liverpool, on Wednesday, January 26, Mr. John J. Webster, M. Inst. C.E., president, in the chair. A paper was read by Mr. Charles H. Darbishire, M. Inst. C.E., on "The Ventilation of Sewers."

Her Majesty's ship Thames, twin-screw, steel, second-class steam cruiser, which was fitted with engines by Messrs. John Penn and Sons, of Greenwich, and was recently sent to Devonport to be fitted out, made the last of her contractors' trials on Tuesday, under forced draught with good results.

Two men, speaking English and German fluently, have been arrested as spies at Lyons. They professed to be Americans, and had been for a fortnight assiduous spectators of the garrison drills, and are said to have offered a soldier 20,000 francs for one of the new rifles and a specimen of the cartridges.

The *Liverpool Journal of Commerce* of the 21st inst. states that a well-known and extensive shipbuilding company have been offered a contract to build two large, fast, and powerful steamers for the Atlantic trade, but refused to accept the offer unless the hands in their employ would agree to a reduction in their wages of 10 per cent.

The Administration Report of the Indian Telegraph Department for the year 1885-86, shows that in the course of the last three years the length of lines has been increased by 17.9 per cent.; and the number of offices by 27·7 per cent.: while the revenue has risen by 23 per cent. and the working expenses have diminished by 3.4 per cent.

A New York telegram of the 19th inst. states that the price of bar iron has advanced, and the vice-president of the Iron and Steel Association has expressed fears that the price of iron will reach the importing point, and that foreign iron will flood the market. He says that to his own knowledge 6000 tons of steel rails have been imported into New Orleans at 2 dols. per ton less than the Pennsylvania mills could supply them.

The Royal Commission upon warlike stores held a sitting last week. Sir James Stephen presided. There were present Sir Archibald Alison, Sir W. Barttelot, Rear-Admiral Sir Nowell Salmon, Dr. John Percy, and Colonel Alleyne (secretary). Colonel Hope, who had on a previous occasion given evidence before the Commission, was recalled, and gave further evidence at considerable length.

The opening of telegraph offices in India, worked by extra departmental agency, and the system of deferred messages, which now form no less than 63.15 per cent. of the total traffic, have made great progress since their introduction. The number of departmental offices has been nearly doubled, and the gross revenue has risen from Rs.38,54,212 in 1881-82 to Rs.51,10,986 in the last year, the the charges against revenue account increasing from Rs.32,35,644 to no more than Rs.36,18,695.

It is stated that the Lords of the Admiralty have decided to create a statistical office in connection with their department. The office will be practically the intelligence bureau of the Navy, and the officers connected with it will be charged with the duty of collecting and, where desirable, of publishing statistical and other information bearing upon naval matters. It is understood that other changes in the administration of the department are impending.

The Cordelia, 10 guns, 2380 tons, and the Calliope, 16 guns, 2770 tons, both corvettes of the "C" class, were commissioned at Portsmouth, on 25th inst., and after making a week's continuous endurance trial of their machinery, will, if all goes well, start at once for the China station. Some adjustments have been found necessary in the propeller of the Calliope, for which she has been placed in the North Dock.

Mr. Broadhurst, M.P., has written to the Nottingham Chamber of Commerce, to point out the importance of the question of commercial education. As to the trade of the country, Mr. Broadhurst thought we were suffering as much from our own folly and deception in the false marking of goods as from any other causes. He did not see any suggestions in the report of the Royal Commission on the Depression of Trade which would be likely to have the effect of improving trade.

A largely attended representative meeting of South Yorkshire steam coal owners and shippers was held at Barnsley last week, Mr. Joseph Mitchell presiding, to consider a circular issued by the South Yorkshire Steam Coal Owners' Association. A circular was ordered to be issued from non-associated South Yorkshire steam coal collieries, stating that the coal shippers at Hull and Grimsby are prepared to ship best South Yorkshire steam coal from the Barnsley bed, and guarantee both quality and weight by colliery certificates.

A *Times* correspondent, writing on the 21st. inst., says, "Yesterday afternoon an important conference was held at the Admiralty between the Chancellor of the Exchequer, Lord George Hamilton, and the permanent heads of departments. The subject was extended from a simple consideration of the office expenditure to a general discussion on all the proposed votes in the Navy Estimates, particularly Nos. 6 and 10, devoted to dockyards and ship's stores respectively."

The *Pall Mall Gazette* has the following paragraph: "The Admiralty, two months since, has been stirring up the dockyard authorities in order to have all our available ships ready to go to sea at a moment's notice. After two months preliminary warning it was thought that the time had come for testing whether the dockyard authorities were up to the mark. So they telegraphed down from Whitehall to have two corvettes sent to sea at twenty-four hours' notice. Back came the answer: 'Can't do it. Calliope's screw defective. Cannot put to sea for a week.'"

In the mills of Messrs. Thomas Rhodes and Sons, of Hadfield, near Dinting, Messrs. Mather and Platt, of Salford, have erected what is believed to be the largest electric light installation at present existing in any cotton mill in this country. It comprises 1400 lamps of 16 candle-power, and is fed by two dynamos, each capable of an output of 44,000 watts. These are of the latest Edison-Hopkinson type, with the lengths of the field magnets still further reduced, and with bar armatures. There are three brushes on each side of the commutator. The armature bars have a section of .106 in., and the load is three ampères per square millimetre. The resistances are as follow: Armature, .00645 ohm; series coil, .0013 ohm; and shunt coils, 17.4 ohms.

The *Times* states that as part of the programme for the ensuing financial year, the Admiralty propose to lay down an additional number of fast torpedo boats, and as the result of the competition which has lately taken place for the new second-class craft, the design and proposals of Messrs. Yarrow and Co. have been selected. The boats are to be of two sizes, although both of the same type. The smaller will be about 13 tons in weight, with a speed of 16 knots, and the larger about 15 tons with a speed of 17 knots. They are to be designed on the same plan as No. 79 first-class torpedo boat recently built by Messrs. Yarrow for the Government and tried on the Thames with the First Lord of the Admiralty on board, when, as it will be remembered, a great success was achieved.

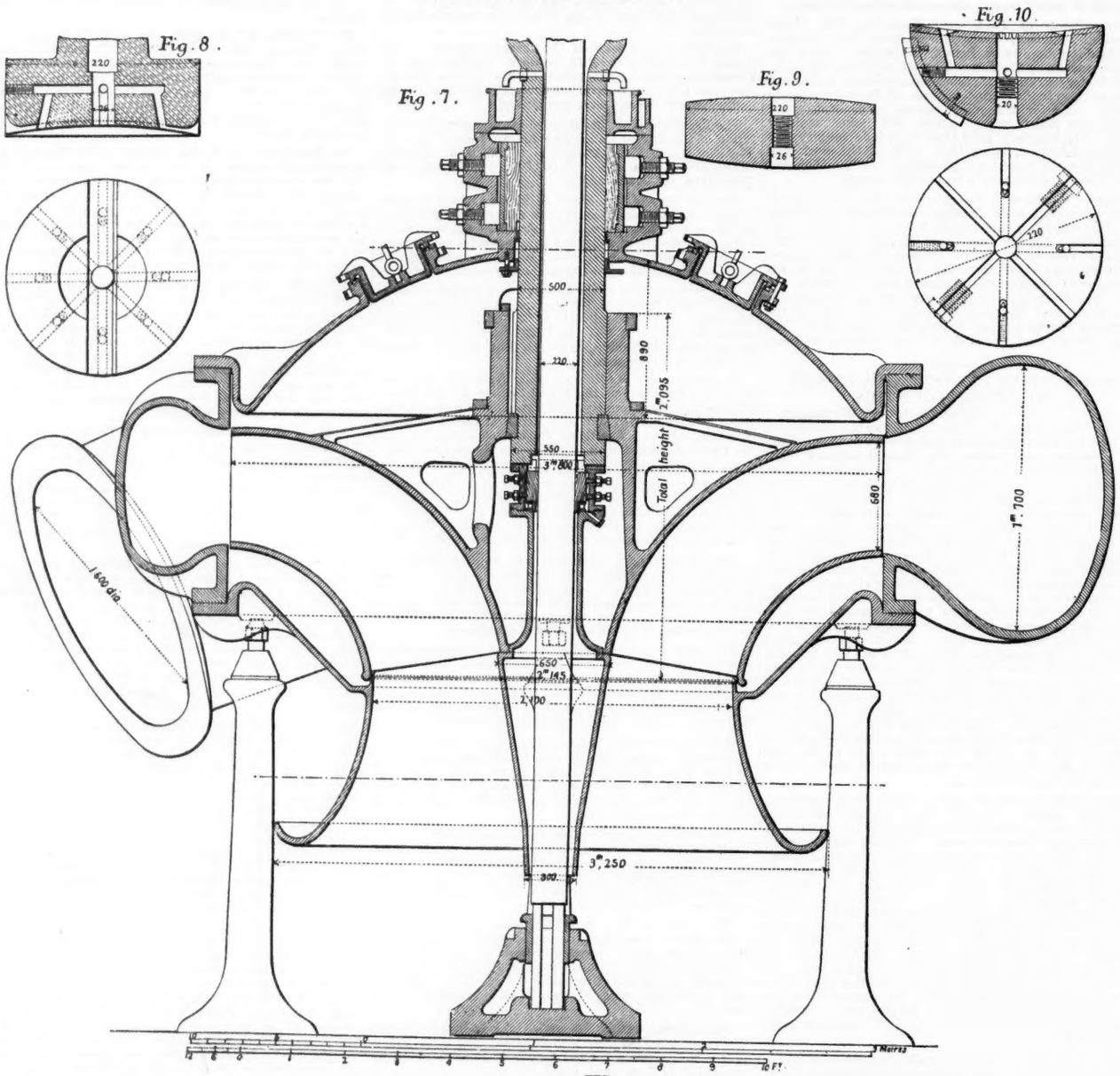
An evening paper has the following:—"Germany has long been in quest of a new weapon, and has at last attained one. Its official name is 'M 71-84.' M stands for Mauser, whose gun was adopted in 1871, but in the thirteen years that followed, the model was constantly being perfected. At last in 1871, the gun of the future was designed, and now, in 1887, it has become the weapon of the German army. It differs from the old model in several respects. The metal contains no copper in its composition, and the barrel is somewhat shorter. In the original Mauser, when a charge was fired, the soldier had to give the stock a smart stroke so as to throw out the used cartridge. In the new gun this is attained automatically. But the chief innovation is the introduction of a reserve of cartridges into the stock of the piece, which in effect converts 'M 71-84' into a revolver. These cartridges are held in a steel tube, which by the operation of a spring can be made to deliver them in succession into the breech. A fully loaded gun contains ten of these charges."

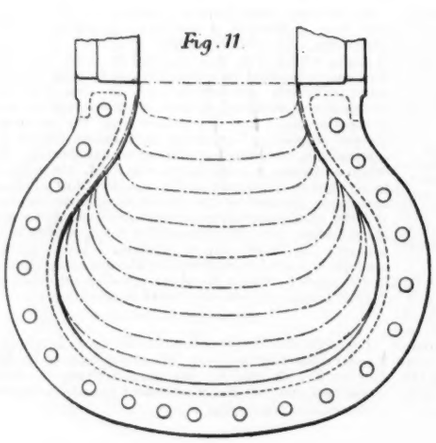
ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—At a general meeting held on Tuesday, January 18, Mr. C. J. Vesy Brown read his inaugural address, in which he mentioned some of the most recent inventions connected with engineering science.

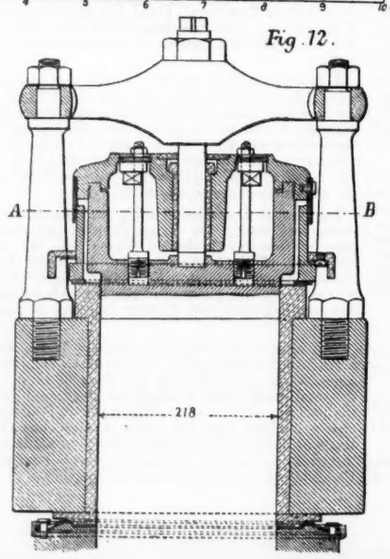
CENTRIFUGAL PUMPS AT KHATATBEH, EGYPT.

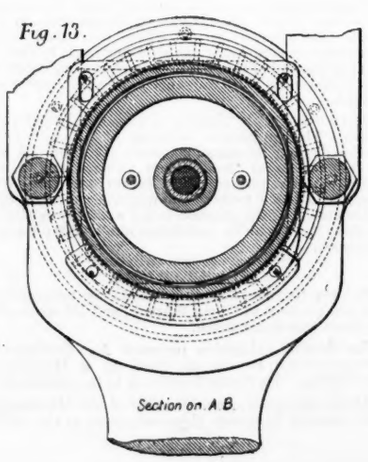
CONSTRUCTED BY MESSRS. FARCOT AND CO., ENGINEERS, PARIS.

(*For Description, see Page* 93.)









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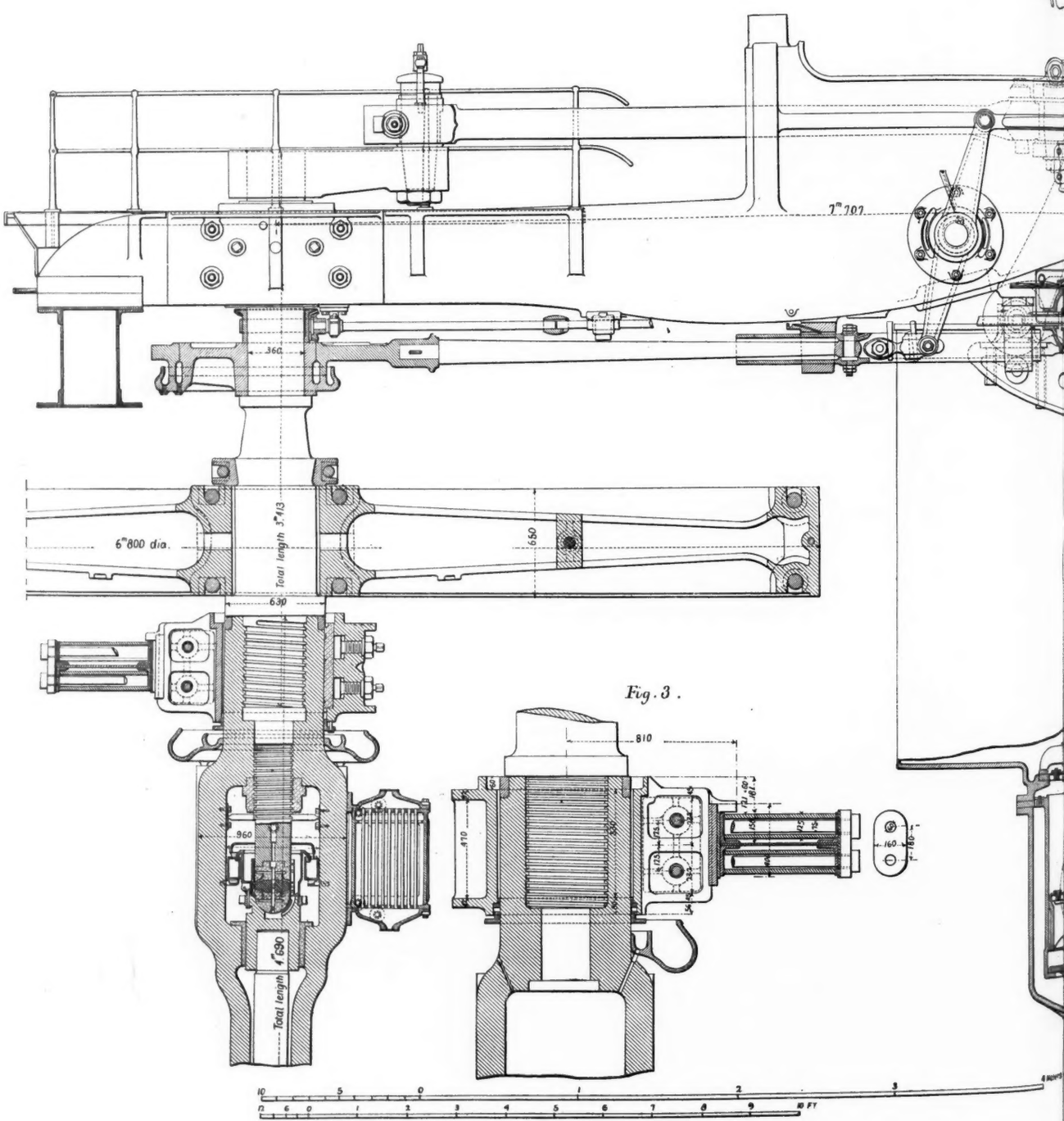
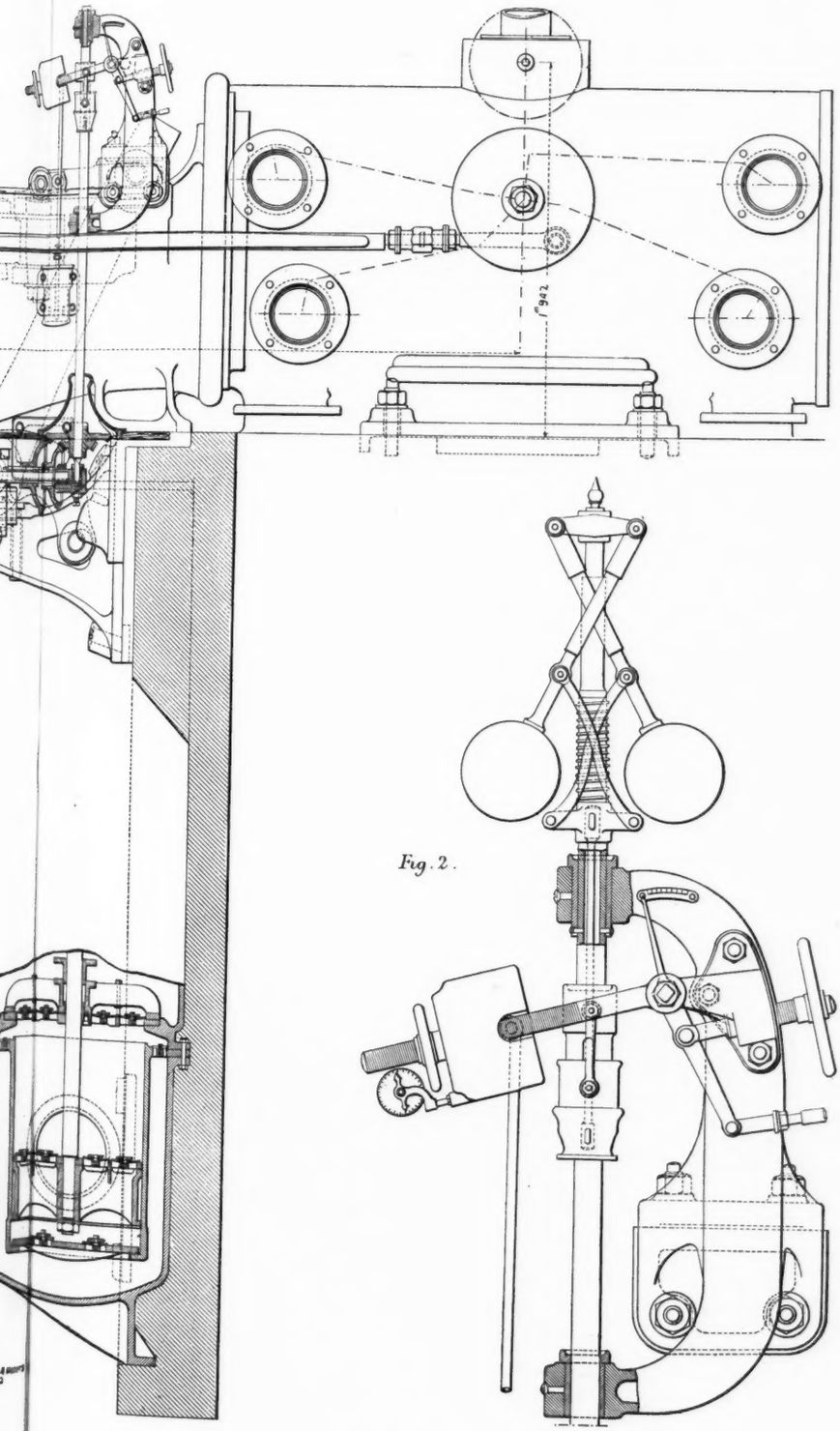


Fig. 3.

ENGINES AT KHATATBEH, EGYPT.

S. FARCOT AND CO., ENGINEERS, PARIS.

(Description, see Page 93.)



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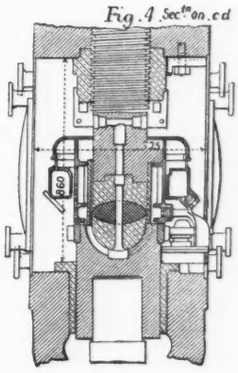

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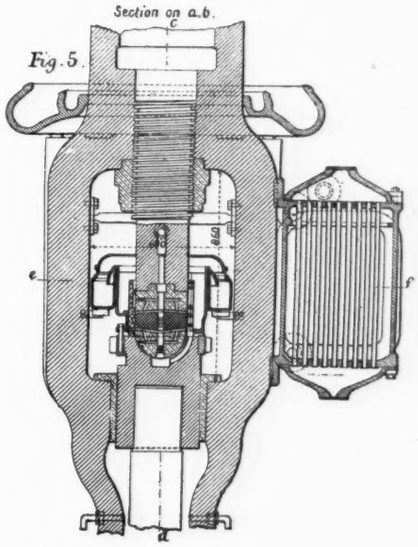
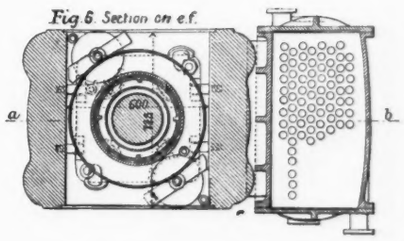


Fig. 6. Section on e.f.



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With a Two-Page Engraving of CENTRIFUGAL PUMPING ENGINES AT KHATATBEH, EGYPT.

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Ordinary meeting, Tuesday, February 1st, at 8 p.m. Papers to be further discussed: "Sewage Sludge and its Disposal," by William Joseph Dibdin, F.C.S., F.I.C. "Filter Presses for the Treatment of Sewage Sludge," by William Santo Crimp, Assoc. M. Inst. C.E., F.G.S.—Students' meeting, Friday, February 4th, at 7.30 p.m. Paper to be read: "Recent Researches in Friction," Part II., by John Goodman, Wh. Sc., Stud. Inst. C.E.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—On Thursday, February 3rd, in the Lecture Hall of the Literary and Philosophical Society, Newcastle-upon-Tyne, at 7.45 p.m., a synopsis of the following paper will be read and the paper discussed: on "The Principle of Work in Relation to the Strength of Materials, and the Fallacy of the accepted Theory of the Strengths of Hollow Steel Shafting," by Mr. H. Foster.

INSTITUTION OF MECHANICAL ENGINEERS.—On Thursday, February 3rd, and Friday, February 4th, at 25, Great George-street, Westminster, by kind permission of the Council of the Institution of Civil Engineers. The chair will be taken by the President at 7.30 p.m. on each evening. The annual report of the Council will be presented to the meeting. The annual election of the President, vice-presidents, and members of Council, and the ordinary election of new members, associates, and graduates, will take place at the meeting. The President, Mr. Jeremiah Head, having been in office two years, will retire, and will induct into the chair the President elect, Mr. E. H. Carbutt. The appointment of a professional accountant, to audit the accounts of the present year, will be made by the members, and his remuneration fixed. Discussion: The discussion will be resumed on the paper read at the last meeting on "Triple-Expansion Marine Engines," by the late Mr. Robert Wyllie, of Hartlepool. Papers: The following papers will be read and discussed, as far as time permits, "Notes on the Pumping Engines at the Lincoln Water Works," by Mr. Henry Teague, of Lincoln; "Description of a Portable Hydraulic Drilling Machine," by M. Marc Berrier-Fontaine, of Toulon; "On Copper Mining in the Lake Superior District," by Mr. Edgar P. Rathbone, of London.

ENGINEERING.

FRIDAY, JANUARY 28, 1887.

MODERN WARSHIPS.

THE Director of Naval Construction gave last Friday, at the Mansion House, a lecture on modern warships, it being one of a series of lectures that has been promoted by the Shipwrights' Company. The numerous audience which completely filled the large room at the Mansion House bore testimony both to the interest taken by the public in the subject, and to the popularity of the lecturer. Lord Charles Beresford presided, and was supported on the platform by a number of gentlemen well known in naval and marine circles generally. The lecture was of a popular nature, but contained, as indeed do all Mr. White's productions, a great deal of valuable and interesting matter.

The period mainly treated of was that between the years 1859 and 1887, an era which "has witnessed greater changes than have taken place in the whole preceding history of war shipbuilding." During this time Mr. White has been in the Admiralty service, except for the short break when he made his journey to the North to become associated with the celebrated Elswick firm. At the time Mr. White entered the service twenty-eight years ago, "the dockyards were," he says, "the scene of feverish activity, the too long-deferred steam reconstruction of the Navy being in full swing. Forced on by the action of Napoleon the Third and his able naval architect, M. Dupuy de Lôme, the Admiralty had at last frankly faced the necessity for fitting screw propellers and steam machinery to the largest class of warships. Full sail power was to be retained and wood hulls (built on the old methods) were to be adopted on all these vessels." Steam machinery was being put into many of the old sailing ships, and Mr. White tells us that he himself assisted at the cutting down of sailing three-deckers and their conversion into screw two-deckers. This conversion of the old type of battle-ship was the last great struggle made by conservatism, which has always been so strong an instinct amongst naval men, for soon the French ironclad, the Gloire, convinced us that the old order had passed away, and England, unless she would be left in the rear, must march with the times.

It is interesting to recall this period of time, which is within the memory of nearly all of us, in the present days of mastless armour-clads and swift torpedo vessels. "The grand two and three-decked line-of-battle ships of 1859-60 represented the largest and finest types that had gradually grown up in the two and a half centuries since the first Master of the Shipwrights' Company, Phineas Pett, breaking away from tradition, gave to the English Navy a fresh start."

Mr. White quoted a passage from Charnock, in which reference is made to the Prince Royal, built by Pett in 1610. "This vessel," it is said, "may be considered the parent of the identical class of shipping which, excepting the removal of such defects or trivial absurdities as long use and experience has pointed out, continues in practice even to the present moment." Charnock wrote his history of marine architecture early in the present century, and Mr. White pointed out how the same style and design of warship was brought down to the date he entered the Admiralty service. A table was exhibited on the walls showing the leading particulars of first-class warships from the Great Harry, built 1512, down to the Victoria launched in 1859. The former was 138 ft. long, 38 ft. wide, and 1000 tons old measurement. She carried 120 guns, 34 of which ranged between nine-pounders and 32-pounders, and was manned by 700 men. The Victoria was a screw vessel 260 ft. long, 60 ft. wide, and 4130 tons old measurement. She carried 121 guns ranging between 68 and 56-pounders. Her complement of men was 1130. One of the most interesting vessels in the list was the Royal William, built in 1670. She bridges over the greater part of the time embraced by the table, as she continued in service up till 1813. As she was twice rebuilt and many times altered during the course of her career, possibly she was very much like the old lady's stockings that lasted twenty years; only wanting "re-footing" in the winter and new upper works in the summer months.

Reference to the Warrior, ordered the year Mr. White joined the Admiralty service, introduced another era in the history of warship building. Although we followed the lead of France in protecting our ships with armour plates, the Warrior was by no means a servile copy of the Gloire. The latter Mr. White pointed out was a wooden hulled, screw, two-decker with armour on her sides. We had converted some of our old two-deckers into ironclads in order to answer the French advance with least delay; but the Warrior was an entirely novel design, "remarkable," said Mr. White, "for its boldness and success even when regarded from our present standpoint." "She was of unprecedented length and size, with iron hull and new structural arrangements and fittings . . . She is to this day a grand and beautiful specimen of naval architecture, and in this sense a monument to the skill and courage of her designers."

The 4½ in. armour and thick wood backing of the Warrior were practically proof against the heaviest shot and shell of those days, but gunnery improved so rapidly that projectiles were soon able to pierce this thin protection, and since that date the battle of guns and armour has gone on uninterruptedly up to the present time. A table was exhibited giving the particulars of English naval guns from the 68-pounder up to the 110-ton gun, such as will be carried by the Benbow, Renown, and Sans Pareil. "Shortly stated, guns have been increased in weight from 4¾ tons to 110 tons, in powder charge from 16 lb. to 900 lb., in weight of projectile from 68 lb. to 1800 lb., in energy (measuring the force of the blow struck on impact) from 450 foot-tons to more than 50,000 foot-tons, at a range of 1000 yards. The 68-pounder failed to penetrate the Warrior target with 4½ in. of wrought-iron armour, at close range; the 110-ton gun can penetrate 35 in. of iron at 1000 yards." Nor is the end yet reached, for Mr. White goes on to tell us that "new projectiles and explosives are being produced which may reasonably be expected to place the attack in an even superior position in relation to the defence." On the other hand, the defence shows to least advantage in peace experiments, a point Lord Charles Beresford enlarged upon subsequently when he pointed out that a target "never hits back," or does anything else to unsteady the nerves of its assailers. Armour that would be easily penetrated if struck square escapes with a dent when it receives an oblique blow. The comparison between the action of the Shah and the Huascar, introduced by the chairman, bears out this case. The practice on board the Shah was excellent, and she struck her adversary a great number of times. Theoretically the ironclad should have been sunk a dozen times over, but as a matter of fact the damage was comparatively trifling.

Some further facts as to gunnery stated by the lecturer may be quoted as being of great historical interest. "In 1599 the largest naval gun, termed 'a cannon,' was 8 in. in calibre, with a 60 lb. projectile; next in size was a 'demi-cannon,' 6¾ in. in calibre, with a 3.3 lb. shot; the culverine had 5½ in. calibre and a 17½ lb. projectile. The demi-culverine was a 4 in. gun. Below these came the small guns which formed a large part of the armament. In a 100-gun ship of 1677 about half of the guns were three to five-pounders. In 1859 the armaments of ships of then recent design consisted chiefly of 32-pounder 8 in. shell guns with 56 lb. projectiles, with one or two 8 in. 68 lb. pivot guns." The guns of 1859 were of course superior in many points to those of the previous date, but both were cast iron, smooth bore, and muzzle-loading. The contrast between the two and a half centuries up to 1859 and the vast strides since made as set forth in the figures Mr. White quoted, and of which we have previously repeated the most striking, is, as he stated, too great to need any comment.

Up to the year 1873 the ram was the only rival to the gun as a weapon of offence, and the most notable changes in warships resulted from the de-

sire, on the one hand, to carry heavier if fewer guns, and on the other to thicken the armour over the protected portions of the ship. The latter was to be obtained by diminishing the area of protected surface. Mr. White had prepared a table giving the leading particulars of typical vessels, from the Warrior to the Trafalgar.

The Warrior was not armour-plated at the ends, so she could not, without change of position, command the horizon by guns placed behind armour. The Minotaur, the next class of armoured ship, was mail-clad from stem to stern, and could sweep the horizon with her fifty guns, but nearly 1800 tons of 5½ in. armour were required for the purpose. The "belt and battery" system was the next development, which was introduced in 1863-67, and was represented by the Bellerophon and Hercules. The principal guns were carried in a box battery amidships, and by means of recessed ports or outlying armoured batteries at bow and stern, all-round range was secured. The armoured surface was reduced on the upper works, and so the mean thickness of armour was increased.

With the Devastation of 1869 the "breastwork monitor" type was introduced, sail power being entirely abandoned. "As first designed," said Mr. White, "the ship proper was a low freeboard structure armoured from end to end in the region of the water line; and upon the central portion of this raft-like vessel stood the armoured breastwork, at either end of which a revolving turret was placed containing two 35-ton guns. A light-armoured forecastle and a flying deck were the only parts of the structure above water which could be easily damaged; practically speaking, as originally designed, the exposed portions of the hull were all shell proof. The four very heavy guns constituted the only armament, and their range of command was complete. Subsequently, for purposes of increased stability, safety, and accommodation, light unarmoured superstructures were built about the breastwork." The Dreadnought, another ship originally of the same type, was, as is well known, greatly altered in design, in fact was redesigned in 1872. The breastwork was brought out to the full breadth, and light superstructures were built above the belt, so altering the design to a "belt and battery" ship of moderate freeboard. She had four heavy guns in two turrets, and carried the enormous load of 3260 tons of armour, the maximum thickness being 14 in.

Mr. White next carried us to the "central citadel" principle, which, in 1874, was introduced in that much debated ship, the Inflexible. Here again we have an armament of four heavy guns in two turrets with complete command of the horizon. But the turrets were differently disposed, and the central armoured citadel containing them was shortened, whilst before and abaft the citadel there was no vertical armour, but a strong protective deck was built across the ship a few feet under water. Mr. White made scarcely any mention of the great controversy, by which the opponents of the design managed to retard the construction of the Inflexible for so long a period, but passed on at once to enumerate the points gained by the "central citadel" principle as applied in the Inflexible. "The maximum thickness of armour on the citadel sides is 24 in., the greatest total thickness as yet put upon a warship. Her turret guns are each 80 tons weight, the heaviest muzzle-loaders mounted on board ship. She represents in the highest degree the principle of concentration of armour and armament."

The Colossus was the next ship referred to. She is also a central citadel ship, and is worthy of notice as having been built of steel, and being protected by steel-faced armour; she was also armed with the new type of 43-ton breechloading gun, and steamed at a high speed, nearly 15½ knots.

Concentration of fighting power having been carried to so high a point in the Inflexible, a reaction set in. The French seeing the weakness as well as the strength of this type of vessel, set to work to build ships in which a few heavy guns were mounted *en barbette* high above water; and associated these with a large number of lighter guns in positions not protected with armour. The Italian designers followed the new policy in the great ships Italia and Lepanto, which carry their four 100-ton guns at the enormous height of 33 ft. above water—20 ft. higher than the turret guns in our low freeboard ships—and which have besides eighteen or twenty smaller armour-piercing guns.

It was to meet these altered conditions that the designs for the "Admiral" class of vessels were got out in 1880. "In all these ships," said Mr. White, "the following principles of construction appear. The principal armament is contained in two barbettes placed high above water towards the bow and stern. Between the barbettes, on a central broadside battery, are the armour-piercing, quick-firing, and machine guns of the secondary armament, also placed at a considerable height above water. The armour is disposed in a manner differing from that of preceding ships. A water-line belt of thick armour extends over about 45 per cent. of the length, protecting the engines, boilers, and communications with the barbettes. At the ends of this belt there are athwartship armoured bulkheads, and at its upper edge is a strong protective deck. Before and abaft the belt armour the ends are unprotected by vertical armour, but there is a strong steel protective deck a few feet under water, with minute subdivision and stowage for coal, stores, &c. The barbettes containing the heavy guns and their mountings are also armoured strongly, both on the sides, top, and bottom, and cylindrical armoured tubes, for protection of the ammunition in transit from the magazines to the guns, extend from the floor of the barbettes to the belt deck."*

The Trafalgar, another much discussed ship, Mr. White describes as a greatly improved and strengthened Dreadnought. In her design the highest ratio of weight of armour to total weight has been attained. Her protection is of unrivalled strength and cost, the 20-in. steel-faced armour being reinforced by inner armour and a strong system of girder work. There are four 67-ton guns in two turrets, and a secondary armament of 5 in., and quick-firing guns in a battery between the turrets. The load displacement of the Trafalgar will be 11,940 tons; her total weight of armour will be 4230 tons. Of this weight 1040 tons will be comprised in horizontal armour in decks, glacis plates, &c. The total weight of armour in terms of the displacement of the ship will be .352; that of the Inflexible is .272, of the Dreadnought .296, and the Camperdown .294. The Nile and Trafalgar are to be of somewhat greater displacement than the Inflexible, and also of the largest French ironclads Admiral Baudin and Formidable. The latter vessel, our readers will remember, is 319 ft. long, 70 ft. wide, and 25 ft. 8 in. draught of water. Her displacement is 11,260 tons, and the horse-power will be 8320 indicated, which will give a speed of 15 knots. The maximum thickness of armour is 22 in., and three 75-ton guns will be carried.

SODIUM.

THE article on "Aluminium" which appeared in ENGINEERING on January 14th, served to bring to our notice a new process for the production of sodium. Up to the present this novel method of manufacture has been kept rather secret, but now, owing to the success achieved by a plant erected and worked on a commercial scale, we are enabled through the courtesy of Mr. H. Y. Castner to lay before our readers an outline sketch of the method of operation which is followed, and which we have seen carried out with success at his works, 65, Belvidere-road, Lambeth. Few persons outside of the chemical profession are aware of the commercial existence of the metal sodium or of its uses, and even among those following that profession but little is known except that it is used in the manufacture of aluminium, and is very expensive. Much has lately been published in various scientific journals throughout the world upon the subject of alleged new processes whereby that highly interesting metal—aluminium—might be cheaply produced without sodium, and thus be made to take in the commercial world a place to which its varied valuable properties entitle it. So far nothing has resulted from these numerous so-called discoveries, and at the present time the only process in use whereby aluminium can be produced is that devised by and due to Deville's ingenuity.† This process has been called the sodium process apparently to distinguish it from others, but seeing that it is the only process which has ever proved practical, it is somewhat of a mystery why it needed to be so distinguished.

The late Dr. Walter Weldon, in a paper read before the Society of Chemical Industry a few years ago, clearly resolved the great question of cheaply producing aluminium, and showed by argument that this end was only to be gained in either of the two following directions, namely: first, by the production of cheap sodium and the employment of Deville's process; and, second, by the discovery of a substitute for sodium which has hitherto given to aluminium its excessive cost in production. After twenty-five years of research by some of the best scientists of the present age, no substance has been found that will replace sodium, and although every known substance has, at various times, been proposed, none have been successful. So discouraging has been the research that those familiar with the subject have almost abandoned hope of ever seeing aluminium cheaply manufactured by chemical processes, believing also that Weldon's first proposition was an impossibility.

It is not the purpose of this article to enter into a lengthy discussion of Mr. Castner's process of producing sodium, as Mr. James Mactear, F.C.S., is about to prepare a scientific paper on the subject, to be read on March 7 before the Society of Chemical Industry. We shall content ourselves by presenting to our readers a short practical description of the process and its results.

Before doing so it will, however, be advantageous to give a short account of the method by which sodium has hitherto been separated from its compounds, in order that a clearer conception of the features in which the new process differs from the old one may be obtained. At high temperatures carbon has the property of separating sodium from its oxygen compounds, carbon uniting with the oxygen to form carbonic oxide, the sodium being thereby liberated. In the usual process this reaction is brought about by mixing carbonate of soda, lime, and carbon in small wrought-iron cylinders, and exposing them to an intense heat, when a part of the sodium comes off as vapour. The lime is added to prevent fusion, for were the mass to melt the carbon would float on the top and could no longer attack the soda. The new process differs from the old principally in working with a fused mass of soda compound, this operation having been rendered feasible by the most ingenious device of weighting every particle of carbon with iron, so that the two chemicals—soda and carbon—are kept in perfect admixture, and are continually presenting fresh surfaces to each other as the liquid circulates in the crucible under the action of the heat. By this simple but beautiful plan of weighting the carbon, it is rendered possible to employ a soda compound, which is decomposed at a much lower temperature than that hitherto used, and to carry on the process in large and durable vessels, instead of in small cylinders which have a very short life. Having thus given a short account of the chemical process we will describe the commercial method of manufacture.

The operations are carried on in large cast-steel crucibles, and the charges consist of caustic soda and a finely ground artificial compound of carbon and iron, which is the reducing agent. This compound is made by coking a mixture of fine iron and pitch. The crucibles containing these materials are first heated in a small furnace at a low temperature, the object being to expel the hydrogen from the caustic alkali and bring about quiet fusion. The crucibles are then removed from this furnace by means of a little truck and placed upon a movable platform which is operated by hydraulic power. They are then by this means raised into the large furnace, where the crucible covers are fixed stationary. The edges of the crucible and cover coming together form a tight joint, and from this cover projects a small tube to the outside of the furnace into a narrow rectangular box known as the condenser. The reduction of the sodium commences soon after the crucible containing the charge is in its place, the vapours and gases passing from the fused mixture through the exit pipe from the cover into the condenser, where the metallic vapours are condensed to metal, while the uncondensed gases escape by a small outlet tube. After the charge is exhausted, the crucible is lowered, and one containing a fresh charge raised in its place; in this manner the process might almost be called continuous.

The actual temperature used in this process to bring about reduction, as measured by experts, has been found to be 850 deg. Cent. By the older method the temperature necessary is about

* An illustration and description of the Benbow, one of the Admiral class, will be found on pages 429 and 431 of our last volume.

† The Cowles electric smelting process described by us on page 39 of our last volume, has only produced aluminium alloys as yet, and it is doubtful whether it can be made to do more than this.

1400 deg. Cent. This is practically the great point of economy in this process, as the high price of sodium has hitherto been owing to the excessive heat used in the older process and the consequent destruction of the wrought-iron vessels. Sodium at present costs about four shillings per pound to produce, while the materials necessary for this quantity, were nothing wasted, would hardly cost four pence. The difference between these two figures represents the wear and tear to the furnace, the destruction of the wrought-iron cylinders, the loss and waste of materials, the excessive labour and care necessary to employ in manufacturing, and fuel. Approximately the cost of these items in producing 1 lb. of sodium by the older process is as follows :

Two shillings is due to the destruction of wrought iron, &c.

One shilling is due to the loss and waste of materials, of which three times the theoretically quantity must be employed.

Eightpence is due to the labour.

Fourpence is due to the fuel.

Mr. Castner seems justified in his claim to produce sodium at a shilling per pound in large quantities. The steel crucibles which have now been in use some time show but little wear and indicate indefinite use in future, thus reducing the first item of cost in the older process to a fraction. There is hardly any appreciable loss or waste of materials, and from four pennyworth of caustic soda is ultimately obtained 1 lb. of sodium. The labour is a very small item of expense and the fuel consumed is less than one-third that used in the older process.

Seventy-five tons of fuel are required by the older method in producing one ton of sodium. From actual results a like amount of fuel will produce over three tons of sodium by Mr. Castner's process. The results from this new process are not obtained by calculations on paper, as the inventor has shown from actual working that his claims are well founded. The process is no longer an experimental one, the furnace now erected having a capacity of 120 lb. of sodium per day, which is probably more than is produced at any works now in existence. The production of sodium at 1s. a pound by this process may be considered an accomplished fact, which ultimately means cheapened aluminium and a solution of the problem that has so long engaged the attention of chemists and metallurgists.

Negotiations have, we understand, already been opened here in London for the patent rights of the process, and it is expected that in the course of the next few weeks the matter will be definitely settled, and the erection of works started immediately for the production of aluminium upon a large scale.

SIR JOSEPH WHITWORTH, BART., F.R.S., LL.D., D.C.L.

BY the death of Sir Joseph Whitworth, which occurred last Saturday, we lose almost the last of the giant race of mechanics who in comparatively few years raised this country to that supreme position in the manufacturing arts which was demonstrated at the great Exhibition of 1851. At that date the name of Whitworth was already stamped on engineering practice, too deeply to be erased, and was the symbol of a system which has since spread over the world, and contains the essential principle of all profitable mechanical enterprise. It would be impossible to find a workshop which has since earned celebrity for its manufactures and brought wealth to its proprietors, in which the methods originated by Whitworth, and ceaselessly preached by him, are not rigorously carried out, and on the other hand it would be easy to point to the failure of many established firms who neglected the lessons he taught, and paid the penalty of their ineptitude in their ruin. Sir Joseph Whitworth was a brilliant example of a man possessed of that penetration which grasps fundamental principles, and then never wavers in his faith or shrinks from the proclamation of his creed. He found the mechanical world without law or order ; every one did that which was right in his own eyes, selecting his own standard, and following it as closely or as loosely as he pleased ; scarcely two standards were alike, and even if they were, it by no means followed that the work done to them corresponded. The result was confusion and waste—waste of time, waste of material, and waste of money. Whitworth perceived that the cure of this lay in the production and acceptance of universal standards of measurement, and in accurate workmanship which should render objects of professedly similar dimensions alike within certain determined percentages of error. The whole of the earlier part of his career was devoted to means for carrying out and popularising this idea, while the work of his later years was built upon it. He saw that the cheapest production and the most accurate workmanship went hand in hand, and that commercial and scientific principles alike demanded the same methods of construction. He took the "true plane" as his starting point, both actually and figuratively, and was never tired of insisting upon its fundamental importance. To many of the present generation of engineers his utterances on this subject bore the appearance of platitudes, and seemed as lacking in originality as would the reiteration of the commandment "Thou shalt not steal" to a lawyer. But both in mechanics and morality there is a tendency to neglect fundamental principles, and the world is the better for being reminded of their existence from time to time.

It is not to be supposed that Whitworth was the first to perceive that accuracy and interchangeability were the essential features of successful engineering practice ; among his predecessors and contemporaries there were many able mechanics who must have felt the evil of the unsystematic processes then in vogue, and have comprehended how they should be remedied. But the task was too great to be attempted by any man who had not both a genius for mechanics and a stubborn strength of will founded upon a perfect conception of the truth of his convictions and an absolute faith in their final acceptance by the public. Such work as this cannot be done by the mere inventor—the man of ingenuity and happy resource—but is the outcome of the philosophic mind, which by its analytical power tears off and discards the external and accidental aspects of a question, and demonstrates its elementary constitution. This was the characteristic of Whitworth's method of procedure. He conceived an ideal perfection and set himself to attain it. Having thought each matter out until he arrived at what appeared to him as finality, he listened to no suggestions of compromise or alternative. He knew that he was right, and started off on the track he had discovered, leaving others to follow as they would. The result justified his confidence, and time brought him his revenge over many detractors. His true plane and his standard measures are found in every engineer's shop in the world ; his screw threads are universally known, and are used in many countries ; the principles of gunnery which he laid down in 1857 are now the alphabet of the science, although they were as a foreign tongue to the experts of the day ; his compressed steel is the ideal metal to which constructors turn in their difficulties ; in a word, the tasks which Whitworth attempted he accomplished, and in almost every instance he has lived to see the triumph of his ideas.

The tale of Whitworth's production of his first true plane has often been told both by himself and others, but is too characteristic to be omitted. When working at Maudslay's, where he occupied a place in the private workroom of his master, it struck him that if two true surface plates were placed face to face they should adhere. The fact that they did not proved to the young mechanic that the method of manufacture was faulty, so he set to work at his lodgings to produce three plates by the now well-known method of scraping. He was entirely successful, and found his immediate reward in the admiration of his fellow-workmen. His pecuniary recompense was to come later, when his self-appointed period of education was completed. It must be remembered that the subject of our memoir did not become a mechanic either by necessity or accident. His father, Charles Whitworth, of Stockport, was in comfortable circumstances as the proprietor of a large day and boarding school, and was able to send his son, at the age of twelve, to have his education completed under Mr. Vint, at Idle, near Leeds. After a year and a half spent there the boy went to his uncle in Derbyshire to learn the business of a cotton spinner. Here he stayed four years, and to all appearance might have remained permanently, as he had for some time filled the position of manager, had he not determined to devote himself to the manufacture of machinery. In 1821, at the age of eighteen, he broke the connection with his uncle by the only way open to him and ran away to Manchester, where he found work at the bench in the shops of Messrs. Crighton and Co. For twelve years afterwards he continued this course of life, moving from shop to shop and gathering experience in all the best fields to be found. For four years Whitworth stayed in Manchester, and during that time he marked out a career himself. He saw that the rapid introduction of steam power was creating an enormous opening for machinery, which there was no adequate means of producing, and that the great want of the times was tools. He therefore determined to go to London, then the home of all good workmanship, and when he had acquired all the knowledge to be obtained there, to commence the manufacture of machine tools. He worked at Maudslay's, Holtzapffel's, and Clement's, and in 1833, at the age of thirty, he returned to Manchester, set up in Chorlton-street, erecting over his premises the sign "Joseph Whitworth, tool-maker, from London."

The years from 1833 to 1854 were devoted principally to the improvement of machine tools, and the records of the Patent Office show that they were spent industriously. During this interval were designed and perfected the whole series of machines which have carried the name of Whitworth all over the Continent. But, before substantial progress could be made in this direction, it was necessary to furnish the workmen with more delicate gauges than they possessed. This lead to the production of the system of standards and of the famous measuring machine. These were not mere modifications of existing apparatus, but were founded on a principle which had hitherto not received the recognition it deserved. This was that the sense of touch was capable of detecting differences of size inappreciable to the eye. This fact was, of course, perfectly well known to every mechanic, but had never been made the basis of a system, for by itself it was incomplete. It is not only necessary that a workman should be able to say which of two pieces is the larger, but he must also be able to determine by how much the two vary, and this can only be done by aid of a machine which will magnify the difference to such an extent that it can be taken account of by the sense of vision. For this purpose Whitworth produced his measuring machine, in which by means of an accurate screw, and an index wheel divided into 500 parts, he could detect differences of $\frac{1}{100,000}$ in. The striking feature of this appliance was that it did not measure by end contact, but by feeling, for by moving it through one division the test-piece was either gripped or allowed to fall, and thus its size was demonstrated within the limit stated. Still more delicate machines have since been made capable of detecting differences of one-millionth of an inch.

The best-known and appreciated piece of work which Whitworth did for the engineering world at this time (1840) was the introduction of a uniform system of screw-threads. Before and for many years after he took the matter in hand, every large establishment had its own system, and as there are no exact theoretical considerations which determine the three constituent characters of pitch, depth, and form, it followed that there was great diversity between the different systems, according as their authors regarded strength, power, or durability as the most important feature. As threads must always represent a compromise between these three qualities, their determination cannot be effected on the general methods which Whitworth usually employed in solving a problem. As an appeal to first principles was out of the question he proceeded by way of compromise, and to this end he gathered an extensive collection of screw bolts from all the principal English workshops, and from these he deduced the average thread for different diameters. The $\frac{1}{4}$ in., $\frac{1}{2}$ in., 1 in., and $1\frac{1}{2}$ in., were taken as the fixed points of a scale by which the intermediate sizes were regulated. The only deviation from the exact average was such as might be necessary to avoid the great inconvenience of small fractional parts in the number of threads to the inch. The proportion between the pitch and diameter varies through the entire scale ; thus at $\frac{1}{4}$ in. it is one-fifth, at $\frac{1}{2}$ in. one-sixth, at 1 in. one-eighth, at 4 in. one-twelfth, and at 6 in. one-fifteenth. This decrease is not so rapid as it would be if the screws were designed so that a man might tighten any one with equal facility. Practical considerations require that a small bolt shall have a fine thread, and a large one a coarse thread. The variation in the depth, among the different specimens examined in determining the scale, was greater proportionally than in pitch. The mean of the angle of the thread in 1 in. screws was found to be about 55 deg., and eventually this

angle was adopted all through the scale. This established the well-known constant proportion between the depth and the pitch of the thread, which is between $\frac{2}{3}$ and $\frac{3}{4}$. The system was rapidly adopted in many extensive engineering establishments, and in 1841 it was introduced into the Royal Dockyard at Woolwich, and into the shops of the Royal Mail Steam Packet Company. Since then it has spread over the whole of the United Kingdom and the Colonies, Russia, Italy, and Germany, and its future extension to all countries which have not already a uniform system, appears probable. But in every part of the world the Whitworth thread is known and screws made to it can be produced.

Up to the year 1854, Whitworth was a toolmaker, but at that date he was diverted into another channel, which brought him little or no profit, and endless vexation and annoyance. When we say that he came into contact with the Ordnance Board, every one who has had to do with that body, will at once understand that he met with difficulties which even he could not vanquish. Indeed, he was not well equipped for the task; his powerful analytical mind, which went right to the heart of a question, never stopping to inquire what was the customary way of treating it, was certain to raise the most active antagonism of officialism. At that time the Government service was far more independent of public opinion than it is at present, and even now it is well known that a man must possess wonderfully persuasive powers to enable him to turn it from the even tenour of its way which it loves so dearly. But Whitworth was no persuader; demonstration "clear as Holy Writ" he could provide in all abundance, but in the art of backstair negotiation he was a novice, despising both it and those who required it. The tale of his gunnery experiment therefore bears a twofold aspect; considered scientifically it reveals a brilliant triumph, and displays all the best qualities of the man—his deep thought, assiduous patience, and penetrating intellectual vision. But from the point of view from which the experiments were made, namely, the immediate introduction of the best military rifle which science could supply, they were abortive, and a source of disappointment to all concerned in them.

The matter arose in this way. The Government had decided to furnish the army with the Enfield rifle, and they were desirous of fitting up a factory with machinery for its manufacture. Hitherto all guns had been made to a great extent by hand, and it was a matter of chance whether they turned out good or bad. It would often happen that two rifles made by the same workman, and to all appearance alike, would give widely different results, and no one knew in what lay the secret of superiority of the one. This was a very serious inconvenience, and as Mr. Whitworth held the highest position in the country as the maker of accurate machinery, Lord Hardinge applied to him for help in May, 1854. As Commissioner to the New York Exhibition, Mr. Whitworth had inspected the State Armoury at Springfield, Mass., and had reported on the suitability of the machinery he there saw for the manufacture of firearms, and in this way the attention of the Government had been directed to the introduction of machinery on a large scale at Enfield. Mr. Whitworth was requested to furnish designs for a complete set of new machinery, but he declined the tempting offer until it had been demonstrated what constituted the difference between a good and a bad rifle. The authorities, unable to detect any difference between similar weapons, had decided that the variations must be due to the machinery by which they were manufactured, and imagined that if the appliances were improved, all the guns would be alike good. But this view did not commend itself to the man who was accustomed to measure to a millionth of an inch, and he refused to lend his assistance unless facilities were first found him to enable him to discover the secret of the correct proportions of a rifle barrel and projectile. The offer was not at first accepted, but ultimately, at the instigation of Lord Hardinge and the Earl of Ellesmere, a shooting gallery, 1500 ft. long by 16 ft. wide and 20 ft. high, was built at Fallowfield, Manchester, and in this the experiments were carried out, with the assistance of two military officers and of Mr Westley Richards.

While the gallery was building Whitworth turned his attention to the subject of siege guns, to which the operations in the Crimea gave a special interest. He constructed a rifled cannon, cast in longitudinal segments, in each of which the line of junction followed the course of the spiral. These, when placed together, so as to form a barrel of a spiral polygonal shape internally, were secured by hoops of wrought iron applied in layers. A small scale model of a gun on this principle was made, but was not proceeded with, but the idea of the polygonal bore thus produced appeared in the small arms which were made immediately afterwards. We cannot follow in detail the course of the experiments which were carried out, and which were conducted in a systematic manner. The first point demonstrated was that if the projectile were lengthened beyond the limit of the Enfield bullet, no disposition of its weight could prevent it turning over with the rate of rifling then in vogue, that is with one turn in 78 in. A series of barrels with quicker rifling, giving every gradation down to one turn in 5 in., were made, and it was found that the best average was obtained with one turn in 20 in. At the same time, the length of the bullet was fixed at 3 to $3\frac{1}{2}$ calibres. The lessons taught by the investigation were that the secret of accurate shooting lay in an improved system of rifling; viz., a turn in the spiral four times greater than the Enfield rifle; a bore one-fifth less in diameter; an elongated projectile capable of a mechanical fit; and, lastly, a refined process of manufacture.

The Whitworth rifle was first formally in competition with the best Enfield muskets at Hythe, in April, 1857, with the results given in the annexed Table:

Rifle.	Range. Yards.	Elevation. Degrees.	Average Distance of Hits from a Given Centre.
			ft.
Whitworth ..	500	1.1	0.37
Enfield	500	1.32	2.24
Whitworth ..	800	2.22	1.0
Enfield	800	2.45	4.11
Whitworth ..	1100	3.45	2.41
Enfield	1100	4.12	8.04
Whitworth ..	1400	5.0	4.62
Enfield	1400	6.20 to 7.0	No hits.
Whitworth ..	1800	6.40	11.62
Enfield	1800		

This shows that the new arm was immeasurably the superior at all ranges. At 500 yards its figure of merit was six times as good as that of the Enfield; at 800 yards it was 4.11 times; at 1100 yards it was more than three times, while at 1400 and 1800 yards the Enfield piece was useless, and therefore no comparison could be made. Other trials against the arms of private makers followed with similar results (see Table), and everything appeared ready for the adoption of the rifle. But neither the weapon nor the inventor complied with the red-taped ideas of the military authorities, who were now no longer under the control of Lord Hardinge, and a committee reported that the bore of the Whitworth rifle was too small for a military weapon. This decision seems to have been based on the idea involved in the Irish difference between "kilt" and "kilt intoirely," for it is impossible for any ordinarily constituted mind to understand what difference it can make whether his enemy be killed with a small bullet or a large one.

Competitors.	Mean Figures at 500 Yards.	Mean Figures at 1000 Yards.	Mean at both Ranges.
	ft.	ft.	ft.
Whitworth	.57	1.77	2.34
Baker	.65	2.86	3.51
Turner	.74	2.85	3.59
Parsons	.75	2.47	3.22
Bissell	.87	3.34	4.21
Aston	.91	3.32	4.23

It is difficult to conceive what must have been the disgust which filled the mind of Whitworth when he found his years of toil dismissed with this puerile objection. The wonder is that he did not throw up the entire subject of arms, and address himself to matters which would be judged by men of reason. But although he was denied his just recognition, the principles he had discovered found root, and in 1862 another committee reported that "the makers of every small bore rifle having any pretensions to special accuracy have copied to the letter the three main elements of success adopted by Mr. Whitworth, viz., diameter of bore, degree of spiral, and large proportion of rifling surface." Again, in 1869, a special committee recommended that the calibre of the breechloading rifle should be .45 in., the exact dimension adopted by Whitworth in 1857 and condemned by the committee in 1859.

Whitworth's experiments with small arms led him forward to the construction of cannon by a very easy step, for the same principles applied to both, and consequently his large guns, at least at first, were built on the same lines as the rifles. At first some brass field-pieces were rifled, and in 1858 a 68-pounder cast-iron rifled gun fired a solid shot through a 4-in. armour plate fixed to the side of H.M.S. Alfred. This was the first instance in which armour plates were completely penetrated. In 1862, again, a flat-fronted steel shell from a Whitworth gun went through $4\frac{1}{2}$ in. of armour and 18 in. of teak, representing the side of the Warrior. Again and again after this date these weapons beat all others, and raised the expectation that they would be introduced into the service, but no amount of demonstration appeared to convince the authorities. In the contest with the Armstrong guns the victory was unmistakably with Whitworth, yet his opponent reaped all its fruits. The subsequent trials at Southport were a revelation in gunnery, and created surprise all over Europe from the distance to which the projectiles were thrown and the small area in which they fell. But it was all to no purpose; the "Woolwich ring" was omnipotent and would brook no interference. It was in vain that Whitworth discounted all their achievements and kept ahead of them in spite of the fact that they had unlimited resources, while he had only a small market in South America, still they always managed to hold him at arm's length until last year, when in consequence of strong external pressure, a director of the Whitworth Company was requested to join the Ordnance Committee, and give the Government the benefit of his experience. The whole record of these gunnery experiments is a source of shame to us as a nation, and a scandal to our administration. The Whitworth guns were possibly not perfect, but it is certain that they were immensely superior to the weapons existing at the time, and that if they had been adopted their faults would soon have been remedied under the combined action of the inventor and the authorities. What a different position we should have been in to-day if wiser counsels had prevailed. The whole of our armament would have been of steel of the best quality, instead of being of a practically obsolete material, and we should have headed the nations of Europe in the matter of artillery, instead of being the worst armed of any.

Whitworth's artillery experiments demonstrated to him the urgent need of a better metal than was available at the time. High carbon steel was too treacherous a material to be used for his purpose, while mild steel was unsuitable on account of the numerous blow-holes which existed in it. Other artillerists at Woolwich and Elswick found the same difficulties, and in consequence of them abandoned steel in favour of wrought-iron coils. But Whitworth saw that guns must be made of the toughest metal obtainable, and he therefore set himself to eliminate the accidental defects of mild steel, by purging it of the gases which caused the blow-holes. To this end he subjected the molten metal to intense pressure during the time of setting, and in this way he produced his celebrated fluid compressed steel. He was not the first to propose, or even to practise, the compression of fluid metal; the Broughton Copper Company had employed the process in their works for twenty years, while Bessemer had patented it for steel in this country, and abroad it had been used at St. Etienne, in France, and at Neuberg, in Austria. Indeed, there is scarcely any instance in which Whitworth was an inventor in the legal sense of the word. All his notable productions had been proposed by others; the true plane, the measuring machine, the hexagon rifle, with a mechanically fitting projectile, and compressed steel, had all been suggested and discussed by others, and the legal plea of "prior publication" could be urged against his claims to being their author. But there is a wider and more real definition of an inventor than that allowed by the Courts of Law, and it has been stated by Sydney Smith in these words. "It does not follow that a man is the discoverer of any art merely because he is the first to say the thing, but he who says it so long and so loud and so clearly as to compel mankind to hear him. It is the man who is so deeply impressed with the importance of his discovery that he will take no denial; but at the risk of fortune and fame, pushes through all opposition, determined that what he feels he has discovered, shall not perish for want of a fair trial." Judged by this standard, Whitworth may

be classed among the great inventive geniuses of this country, and it is only a mean mind that would seek to detract from his fame because the materials out of which he forged successes were the failures of his predecessors.

But to return to the compressed steel. The rings for the guns were cast in vertical steel moulds capable of withstanding a pressure of 6 tons per square inch on the fluid metal. The mould was lined with longitudinal bars with rounded corners, and inside these was a porous annulus of refractory material. The core was similarly constructed, and when the metal had been run, the whole was subject to hydraulic pressure, which could be varied between 2000 and 8000 tons. At first there was an escape of metal past the plunger which entered the mould, but this was rapidly stopped by the chilling of the escaping film, and then the metal took the full pressure. The gases were forced out sideways through the sand, and escaped upwards through the interstices of the bars until they reached the upper end of the mould, where they burnt with a fierce flame. So great was the evacuation of gas, that with a pressure of 6 tons per square inch, a cylinder 8 ft. long was reduced to 7 ft. in five minutes. The good quality of the metal soon recommended it for other purposes than guns, and it is now extensively used for the propeller shafts of vessels, for liners of steam cylinders, and for many other purposes. When a pressure of 20 tons per square inch is applied the ingot is said to need no forging, but with smaller pressures it is forged by hydraulic pressure to its ultimate form. Upon the value of the process impartial evidence is furnished by the Gun Foundry Board appointed in 1883 by the Government of the United States. "The Board was allowed the privilege of carrying on its investigations within the works, where, under orders from Sir Joseph, his representatives exhibited, with explanations, the operations carried on in this unique establishment. It may be distinctly asserted that the experiences enjoyed by the Board during its visit amounted to a revelation. . . . In speaking of the Whitworth establishment at Manchester as unique and of the process of manufacture at that place as a revelation, reference is specially made to the operation of forging. . . . The system of forging consists in compressing the liquid metal in the mould immediately after casting, and in substituting in the subsequent forging of the metal the hydraulic press for the hammer."

Whitworth's talents were not of that unsatisfactory order which benefit every one but the possessor. He had keen business acumen, and was a splendid judge of character, surrounding himself with men capable of imbibing his spirit and carrying out his ideas. As a result he made money rapidly, and was able to indulge in many pleasures outside of his profession. He was a breeder of shorthorns, and took a great interest in horses, while in later years he spent much time in landscape gardening, a pursuit for which the possession of a miniature mountain adjoining his residence in Darley Dale, Derbyshire, gave him unlimited opportunities. In 1869 he gave the enormous sum of 100,000*l.* to found scholarships for the promotion of mechanical science, and every year 3000*l.* are distributed from this source among the younger engineers in this country. Such an instance of generosity during the lifetime of the donor is almost unknown, and is remarkable evidence of the public spirit and generosity of the man, while the terms of competition which he proposed, so as to render the prize obtainable both by the artisan and the student, mark the intensely practical form which his ideas took.

The great mechanical, scientific, and philanthropic activity of which we have been able merely to mention the most remarkable features was not without some public recognition. In 1857 Whitworth was elected a Fellow of the Royal Society, and was created LL.D. (Dublin) and D.C.L. (Oxford). In 1867 he received at the Paris Exhibition one of the five great prizes allotted to England. In 1868 he was appointed by Napoleon III. to the Legion of Honour. In 1869 he was created a baronet.

Sir Joseph Whitworth's first wife, Miss Fanny Ankers, died in 1870, and in 1871 he married Mary Louisa, widow of Mr. Alfred Orrell. For about a quarter of a century he lived at the Firs, Fallowfield, where the well-known shooting gallery still recalls him to the neighbours. His later years were spent at Stancliffe, near Matlock, in the county of his boyhood and early manhood.

MACHINE GUNS FOR THE ARMY.

MACHINE guns have taken so prominent a place in the consideration of naval men that it is not surprising to hear a good deal of astonishment expressed at times that this class of weapon has not found more favour in the military branch of Her Majesty's forces. We are now furnished with an explanation of the seeming paradox by means of a lecture given last Friday at the Royal United Service Institution by Major A. D. Anderson, R.H.A., and by the discussion by which it was followed. "The terrific power developed by these weapons effectually silences all detraction from their value as implements of war, while military writers speak of them with respect, but remark that some solution as to their efficient use and adaptation to the field tactics of the present day is necessary." This is what Major Anderson said in his lecture, and the remarks of other military authorities bore him out in his statement. It would appear from this that the inventor and manufacturer have done their part in producing a most efficient weapon of warfare, but up to the present their labours have been thrown away, so far as the army is concerned, because "the authorities" had not been able to determine whether these weapons were best suited for infantry, artillery, or cavalry.

Major Anderson opened his lecture by reference to the vast importance of the results that may be wrought through the possession, by an army in the field, of a superior weapon, illustrating his subject by the campaign of 1866, and the part then played by the Prussian needle-gun. The inefficiencies of the machine gun have been overcome. It has been found suitable and efficient enough for the Navy. Shall it be used for the Army? This is the question Major Anderson set himself to answer, and his answer is a very decided affirmative. On the other hand, he quotes General Brackenbury, who says, "But their (machine gun) advocates have never yet put forth a complete scheme showing how they are to accompany infantry in the field, acting on the offensive over all sorts of ground, and this must be done before they can be accepted for that purpose."

Major Anderson thought that for exceptional purposes machine guns might be used with artillery, cavalry, or as a separate corps with advantage, but he determined not to discuss those points, as he thought it would be generally determined that machine gun fire should be a multiple of infantry fire, and use the same ammunition. The machine guns should be able to go everywhere with the battalions, and without entailing extra labour on the men. The guns, therefore, could not be on wheels, and so must necessarily be worked on tripods and carried on packs. Of course the ubiquitous mule is to be impressed into the service, a machine gun with spare pieces, &c., being estimated to form a load for one mule, whilst a second would carry ammunition. General Hamley, who presided, afterwards pointed out in the discussion, that as a 10-barrelled Nordenfeld could fire 1000 rounds a minute, it would require eleven mules to carry the gun, together with a ten minutes' supply of ammunition. The argument was a somewhat unintentional compliment for the gun, but doubtless the inventor would be equal to curing this defect of excessive rapidity of fire. Major Anderson gave in his lecture an imaginary case of an engagment of two divisions of all arms when machine guns were supposed to play an important part, and concluded a very able and impartial treatment of the subject with the following passage: "The nation which neglects to make use of machine guns in the field will not only incur a heavy responsibility, but will undoubtedly suffer severely if opposed to them."

We would call attention to the good work done by those naval and military officers who compose the Royal United Service Institution. After the proceedings of last Friday "the authorities," who ever they may be, can hardly postpone the introduction of machine guns into the army for a much longer period.

NOTES.

A COMBINED CRUISER AND TELEGRAPH CABLE SHIP.

THE idea of building mercantile vessels in such a way that they can be of service as naval cruisers has found expression in an advanced form in the steamship now being built by Messrs. William Doxford and Sons, of Sunderland, for the China Telegraph Service. This vessel is provided with all the usual apparatus for the laying and repair of submarine cables, and in addition she carries six large guns. Of these, four are in the 'tween decks, with specially constructed water-tight ports, and two long range 6 in. Armstrong breechloaders, are on the upper deck. For the accommodation of these latter, which are arranged as bow and stern chasers, the windlass and steering gear have been considerably modified, so that they may offer no obstruction to the fire. The guns are mounted on cylinders 5 ft. in diameter, built of steel on the 'tween decks, and the stern weapon has an all-round fire up to 68 deg. before the beam. The hull is of Siemens-Martin steel, $\frac{3}{4}$ in. thick, and measures 220 ft. by 32 ft. by 20 ft. It is fitted with triple-expansion engines indicating 1100 horse-power, and calculated to drive it at thirteen knots an hour.

NEW SHIPYARDS IN THE BLACK SEA.

We have repeatedly of late drawn attention to the progress Russia is making in the Black Sea, where a million sterling is being expended in improving the various ports from Otchakoff to Batoum. We have now to announce several fresh enterprises which may exercise an important bearing on the development of the mercantile marine in the Black Sea. At Nicolaeff, not only are the firm of Cockerill and other Continental capitalists making preparations for their large engineering works and shipbuilding yards, but another shipbuilding yard has been also commenced. This belongs to a Russian capitalist, Kundisheff-Bologdin, and will be opened in the spring. Considerable orders for machinery for it have been placed abroad; let us hope in this country as well as others. At Odessa two undertakings are under way. One is a shipbuilding yard and engineering works started by the firm of Bellino-Fenderich and Co., and the other a coasting steamer company, founded by Admiral Zelenoi. Excluding Cockerill's, the rest of the enterprises are entirely without Government support, and indicate the existence of greater commercial activity on the part of Russia in the south than credit is given for in this country. Doubtless, were things more settled on the Continent, we should hear of a deal of German and French capital being invested in the Black Sea region. By the rapid perfecting of communications with Turkey, Germany and Austria are able to compete favourably with England in the Black Sea and Asia Minor, and, if consular reports are to be believed, our merchants by their apathy give them every encouragement to dominate the markets there.

THE THEORY OF THE ELECTRO-MAGNETIC TELEPHONE TRANSMITTER.

An interesting contribution to this question was made by M. Mercadier in a recent number of the *Comptes Rendus de l'Académie Française*. On the ground of some novel and some already accepted experimental evidence, M. Mercadier holds that the mechanism by virtue of which the telephonic diaphragms execute their movements is analogous to, if not identical with, that by which solid bodies of any form, a wall for instance, transmit to one of their surfaces all the vibratory movements of any kind which are produced in the air in contact with the other surface. It is a phenomenon of resonance. Movements corresponding to particular sounds may be superposed in slender diaphragms, but this superposition must necessarily be disturbing under all but exceptional circumstances. In proof of this view it is cited, that diaphragms much too rigid, or charged with irregularly distributed masses over the surface, or pierced with holes, or otherwise evidently unfitted for the purpose, are available for transmission. They will likewise serve when feathers, wool, wood, metals, mica and other substances to the thickness of 4 in. are placed between the diaphragm and the source of vibratory movement. The magnetic field does not alter these relations in any way. The real diaphragm may be removed altogether. It is sufficient to replace it by a few grains of iron filings thrown on the pole covered with a piece of pasteboard or paper. Such a telephone works distinctly although feebly, but any slender flexible disc, metallic or not, spread over across the opening of the cover of the instrument; with one or two-tenths of a gramme (three grains) of iron filings will yield results of increased and even ordinary intensity. This is the iron-filing telephone, which is reversible; for a given magnetic field there is a certain weight of iron filings for maximum intensity. It appears thus that the advantage of the iron diaphragm over iron filings reduces itself to presenting in a certain

volume a much more considerable number of magnetic molecules to the action of the field. The iron diaphragm increases the telephonic intensity, but is by no means indispensable.

THE RUSSIAN PUBLIC WORKS BUDGET.

The Russian Budget for 1887 contains some interesting particulars with regard to the department of railways and canals, presided over by General Possiette, whose jubilee was celebrated the other day. The total amount of the grant to the Ministry of Ways of Communication is 2,564,247*l.* This is composed of 166,627*l.* for the Central Administration, defraying the cost of the Ministry at St. Petersburg; 150,500*l.* for the local administration in various parts of the empire; 452,580*l.* for the maintenance and construction of canals; 552,286*l.* for the maintenance and construction of roads; 1,200,000*l.* for the maintenance of railways belonging to the State; 14,900*l.* for educational purposes; and about 30,000*l.* for sundries. The budget of the minister is about 60,000*l.* less than last year, and presents evidences of severe economy exercised, we fear, in the wrong quarter. Thus, while the outlay on the Ministry itself has increased 7000*l.*, the expenditure on canals has decreased 3700*l.*, and on public highways by nearly 100,000*l.* The roads of Russia have never had a good reputation, but the fall in the money allowed for their maintenance from 657,862*l.* to 552,286*l.* in a single year will render them in many parts intolerable. The increase on State railroads is 73,000*l.*, but this does not include the working of such railways as the Transcaspian line, from the Caspian to the Oxus, 700 miles, which is under the control of the Minister of War. Besides this normal budget there is to be an "extraordinary outlay" this year of 4,841,419*l.*, which is less by 420,000*l.* than the similar grant of 1886. This special expenditure comprises 3,000,000*l.* for the construction of the Gomel-Briansk, Romni-Krementchoug, Samara-Ufa, Ufa-Zlataoust, Transcaspian, Pskoff-Rjeff, Sedlitz-Malkin, Baranovitchi-Belostock, and Rjeff-Vyiasma railways, and the tunnel under the Suram Pass; 545,800*l.* for the manufacture of rolling stock of the State railways; 406,100*l.* for the purchase by the Government of railways belonging to public companies in an insolvent condition; and 371,000*l.* for the improvement of ports, chiefly in the Black Sea. If one lumps the two budgets together, it is impossible not to feel that the expenditure is very small for the public works department of a whole empire two or three times the size of Europe. As a matter of fact, both Canada and Australia respectively spend more on public works yearly than Russia, and as a natural consequence become every year more serious rivals in the markets of Europe.

ANCIENT AND MODERN LOCKS AND KEYS.

At the last meeting of the Edinburgh Architectural Association a paper was read by Mr. Harry W. Chubb, of London, on "Ancient, Mediæval, and Modern Locks and Keys." After referring to the interesting ethnological comparisons supplied by the discoveries of keys of similar shape and use in ages and countries far apart, the author proceeded to describe the growth of the rudimentary lock which was actuated by a sickle-shaped key, and traced its origin from the plain bar sliding in staples. Further development was stated to have resulted in the Egyptian lock, the sliding bar appearing in this lock, but in a hollow form—the means of retention when in its locked position being pins which dropped into it from its staples when shot home. Such a lock is indicated in the wall sculptures of the Temple of Karnac, and is in use in Egypt at the present day. It is in the Roman locks that traces of the system of "warding" first appear, combined also with the falling pins just referred to. Seven varieties of Roman keys attached to finger rings were exhibited on diagrams, and it was pointed out that in one of these the barrel was bored through from end to end, thus allowing accumulated dust to be push out; and *apropos* of this circumstance, the author remarked that it was curious to note that within recent years no fewer than four patentees had applied for protection of the same idea in England. Padlocks were treated by Mr. Chubb as a distinct branch, and being specially connected with travel, the English kinds have become widely distributed. The same mechanical arrangement that was used in the Roman padlock is seen in that of China of the present day. The absence of any distinct Byzantine locks and keys was commented upon, and the gradual growth of ornament upon this form of metal-work from the beginning of the twelfth century was sketched by Mr. Chubb, special notice being taken of it as it advanced through the developments of the pointed style. Up to the commencement of the present century the only security attained was by complex systems of "warding," excepting the still well-known puzzle padlock, which was probably invented in the earlier part of the seventeenth century. Mr. Chubb briefly touched upon the state of perfection of modern knowledge and practice in lock-making and specially referred to locks not commonly known in England. A Chubb lock was exhibited which showed that a variation of only the two-hundredth part of an inch in one of the steps of the key was sufficient to render the key useless. The paper was very fully and successfully illustrated by a series of diagrams (about thirty in number) executed by Mr. C. S. Wimbush, of London.

PERSIAN RAILWAYS.

The announcement in the *Times* that the Minister of Public Works in Persia has gone to Moscow with the alleged intention of promoting a Russian society for the construction of railways in Persia, is a fresh indication of the decadence of British influence in that country, and the waning of British enterprise in a quarter in which it was once very much rife. It was not so many years ago that Persia was looked upon as a close ally, and the management of affairs in the country was largely under our influence. The successes of Skobeleff on the one hand, and the coldly neutral policy of Mr. Gladstone's Government on the other, put an end to this; and either from equal indifference or despair, the present Government has made no effort to recover the ground that was lost. In this manner Russia now enjoys predominant influence in Persian affairs, and is able to mould industrial matters to her advantage. Rather late in the day English statesmen have discovered that diplomacy need not dishonour itself by supporting great industrial schemes, in which the trade of the country may be vitally interested; and are following, although tardily and unwillingly, in the paths of Germany and France. It is to be regretted that the discovery did not come a decade earlier, when there were many English projects for opening up Persia by railways, one or two of which might have matured had diplomatic support been available at Teheran. If Russia, owing to her geographical position, is able to rival other competitors in opening up Persia from the Caspian Sea, we, on our part, exercise predominant power in the Persian Gulf. To this region Russian expansion is assuredly tending, and if the proposed railway from Resht, on the Caspian, to the Persian capital be completed under the auspices of Moscow, the movement will be accelerated. Still, the notion that Russia will be sure some day to get to the Persian Gulf, and that our opposition to her in that quarter will die out, is a view that can be only held by those who are ignorant of the political and commercial geography of the region. If Russia were allowed to annex down to the Persian Gulf, she would split Europe and Asia in halves, and every land route between east and west would be under her control. Rapidly railways are extending from Europe towards India, and from India towards Europe; and the day is not far distant when junctions will take place at different points. That Protectionist Russia should dominate the traffic of every line, will unquestionably not recommend itself to Europe, certainly not to England, who—a fact that Political Socialists are apparently ignorant of—is interested in trade in the Persian Gulf to the extent of 1,000,000*l.* a year. The amount might have been very much larger if British enterprise had been properly supported by the Government at different times.

THE PHONOGRAPHIC LOCMANAUD.

A new rival to the telephone has been advanced. The apparatus is as odd as its name, and as mysterious as the history of its inventor, Lancelot Hope Everett, of New Orleans, U.S.A. In 1863 Mr. Everett obtained his first locmanaud patent, in 1868 a second one was granted, but the inventor had sailed for England in 1867, and has never since been heard of. Mr. Henry C. Strong, of Chicago, has recently filed a petition to declare the said Everett dead, and to protect his models, at present exposed to view in the Patent Office. Should these be lost it would deprive the United States of most important evidence in the great suit against the Bell Company. These respective models puzzled the examiners of the Patent Office a good deal; they went to "Signals" first, and finally found an asylum among "Philosophical Apparatus," where Mr. Strong discovered them. The locmanaud (*locutus*, speak; *manus*, hand; *auditum*, hear) means a machine that receives, conveys, and communicates intelligence by means of similar and dissimilar sounds, representing the different letters, &c., according to certain phonic formulæ. The parlour locmanaud for the deaf and dumb or blind is placed on the table between the two who are anxious to communicate with one another. It consists of a marble pyramid on which the various formulæ are engraved partially coloured for the assistance of those who can see, and of the acouglottic battery, whose parts are named after the ossicula and cavities of the ear, incus, malleus, phonicfossa, tympanum, &c. To give an idea of the apparatus and its mode of working would require a long account, and for details we refer our readers to an illustrated abstract in the *New York Electrical Review* of June 5, 1886. Another apparatus was designed for the benefit of the deaf and dumb and their preachers; copper wires are centred in the "facial incus" of the acouglottic battery before the preacher and diverge fan-like towards the assembly; each member has one wire, held either between the index finger and thumb tips, or inserted into the external ear. These curiosities would hardly frighten Mr. Alexander Graham Bell, but the second patent marks a decided step in advance. This patent claims "an acoustic battery for telegraphing, a machine which creates and modulates sounds that when arranged and sounded under specific symbolic formula they are made to represent and express all letters, &c.," and when thus evoked into existence the machine reflects these sounds and transmits them through naked wire, buried in the land or water, to their destinations, where they impart their various interpretations with such distinctness to the auditor as to become the most important and efficient commissioners of intelligence.

THE LAHORE TRAMWAY.—Robson and Co., Mayo-road, Lahore, ironfounders, &c., have not only made the tramcars, &c., for this tramway, but have also constructed the line, of which three miles are now open for traffic, and 2½ miles more will be finished by March next. This is the first tramway that has been established in the Punjab, and with the exception of the rails, which have been supplied by Fleming, Wilson, and Co., London and Bombay, the whole of the plant has been manufactured by Messrs. Robson and Co., including wheels, axles, springs, &c. There is every probability of several other towns in the Punjab following the example of Lahore, and establishing tramways, both for passenger traffic and as an auxiliary to their sanitary arrangements.

STEEL SAILING BOAT FOR MR. STANLEY.—Mesars. Forrestt and Son, London, have just completed in thirteen working days for the use of Mr. H. M. Stanley's African party, a steel whale boat 28 ft. long of 6 ft. beam and 2 ft. 6 in. deep. It is built throughout of Siemens-Martins steel, galvanised and divided into twelve sections, each weighing about 75 lb. The fore and aft sections are watertight, giving a large amount of buoyancy to the boat. The sections are bolted together, india-rubber being used between the joints to make them water-tight. The boat pulls ten oars, and is fitted with a large lug sail. She will carry twenty-two men and 1000 lb. of baggage on 17 in. draught of water. The thwarts are of mahogany, and all the fittings are made movable. Each of the sections may be carried easily by two men. The boat was tried on the Thames, both sailing and rowing, and proved to be perfectly water-tight at the joints of the sections. The little vessel can be put together in 35 min., and taken to pieces for transport in 22 min. The boat was shipped on the Navarino of the British India Fleet, belonging to Messrs. Gray, Dawes, and Co., who are forwarding all Mr. Stanley's equipment to Zanzibar.

ALUMINIUM.—Messrs. French and Plumb, of 36, Lombard-street, E.C., European agents of the Cowles Electric Smelting and Aluminium Company, of Cleveland, U.S.A., have contracted with Messrs. R. E. Crompton, of Chelmsford, for the immediate construction of a dynamo at least one-half larger than the Colossus machine built by the Brush Company in America, and now running in the Cowles Company's Works, a description of which has been already published by us. This Crompton machine will have a guaranteed minimum working capacity of 300,000 watts, and will be by far the greatest dynamo yet constructed. The Cowles Company is now also having constructed at the Brush Works in America two more of the same capacity as the first above-mentioned machine now in their works. Messrs. Brown and Boby, of London, engineers to the European branch of the Cowles Company, are also now obtaining proposals for two additional dynamos, each of which will have a minimum working capacity of over half a million watts, and they will each require over 800 horse-power to drive them. These are for the new works, of 3000 horse-power, shortly to be erected in Great Britain.

ROTATIVE ENGINE FOR MINE PUMPING.

A VERY large engine was erected some time ago by Messrs. James Simpson and Co., Limited, of Grosvenor-road, London, S.W., for the Throckley Colliery Company, near Newcastle-on-Tyne, to lift about 2000 gallons per minute from a depth of 360 ft. The low-pressure cylinder is 51 in. in diameter, with a 9 ft. stroke, the high-pressure cylinder having a ratio of about a third. The pump is of the piston and plunger type, the piston being 24 in. in diameter, with a 9 ft. stroke. The water is raised in one lift from the bottom of the shaft to the surface. The spear rods connecting the pump plunger to the beam are made of wrought iron tubes with flanges bolted together. The guides for the spear rod are rollers placed about 14 ft. apart from the top to the bottom of the shaft. The weight of the spear rod is about 59 lb. per running foot, which is much lighter than timber spears backed with iron. The engine started work last January, and after it had been running three months, Mr. John Bell Simpson, of Blayton, made a trial with the engine, and found that the measured delivery of the pump was within 3½ per cent. of the theoretical displacement. The horse-power in water measured was 259, and the duty 88.7 millions, the coal being that supplied by the colliery. Since January 1886 the engine has pumped continuously, and the average quantity of gallons pumped per month during last year is as follows:

Month.	Number of Gallons.	Engine Going in Minutes.	Engine Standing Minutes.
January	39,521,475	19,770	24,870
February	47,450,375	21,345	18,975
March..	59,736,075	25,935	18,705
April	62,338,150	28,155	15,045
May	62,228,075	28,745	15,896
June	58,291,625	26,630	16,570
July	66,152,100	29,835	14,805
August	71,544,725	29,235	15,405
September	65,464,875	30,120	13,080
October	60,352,950	30,240	14,400
November	54,992,525	27,000	16,200
December	61,854,275	31,265	13,375

Making a total for the year of about 3,200,000 tons.

The engine has worked in a very satisfactory manner, and there have been no stoppages except during that period when there was no water to pump.

In a letter dated the 12th inst., which has been shown to us, Mr. John Bell Simpson reports as follows: "The engine has worked most satisfactorily during the last twelve months since it commenced, and has worked about sixteen hours per day regularly and pumped about 2000 gallons per minute, and during the year raised about 3,000,000 tons of water. The pump valves have never been repaired or looked at since we commenced. All I can say is, that in economy and efficiency the engine is most successful." Mr. Cheesman, the manager of the colliery, also reports on the twelve months working, "That with the exception of having to replace four bolts in the pump work and a slight repair to the air pump which was of no consequence, the engine has worked very satisfactorily and has not given us the least trouble whatever."

TOOTHED GEARING.

To the Editor of Engineering.

SIR,—Regarding "Toothed Gearing's" letter in your issue of the 14th inst., if pinion wheels were divided off by different methods in the arc and chord pitch, they would not work satisfactorily. Some time since I had the gearing of a 20-ton crane under my notice, the bevel pinion of which was continually breaking. In going into strengths of pinion I found it very much too light for its work, and finally adopted a steel pinion, with shrouded teeth. This has now been going some time with satisfactory results.

Yours faithfully,
JOHN W. LOGAN.

Berwick-on Tweed, January 22, 1887.

To the Editor of Engineering.

SIR,—Referring to Mr. Hartland's letter in your last issue, I should think it is he who misunderstands "dear old Templeton," as on page 241 of his "Workshop Companion," eighth edition, the constant 3.236 is given for a wheel of ten teeth, which, for 3 in. pitch, makes the diameter of the pitch circle 9.708 in. Considering 3 in. as the *arc pitch*, the diameter should be $\frac{10\times3}{\pi} = 9.549$ in.

but considering 3 in. as the *chord pitch*, the diameter is

$$3\times\operatorname{cosec}\left(\frac{180^\circ}{10}\right) = 9.708 \text{ in.}$$

which is exactly the same as Templeton's constant gives, so that evidently "dear old Templeton" means the pitch to be taken as a chord of the pitch circle.

Turning now to Molesworth, I think "Omicron's" letter sufficiently explains why Mr. Hartland could not find the constants I used. My edition is the seventeenth, and on page 206 he will find it distinctly stated that the constant

$$= x = \operatorname{cosec}\left(\frac{180^\circ}{N}\right)$$

where N is the number of teeth; this of course would give for the diameter of the pitch circle, calling P the pitch,

$$P \operatorname{cosec}\left\{\frac{180^\circ}{N}\right\},$$

but this is the formula for finding the circumscribing circle of a polygon of N sides of length P. Here again Molesworth is in direct opposition to Mr. Hartland's dogmatic assertion that the chord pitch is never made the basis of calculation. As in the newer editions, the tables refer to *arc pitch*, we have now two editions of the same authority differing in one of the most useful tables in the book. Are not "mixed ideas" likely to result from such a state of things?

Referring to my "extraordinary paragraph" Mr. Hartland does not state the problem correctly, and it is required to find the diameter of the circumscribing circle of a polygon having given length and number of sides; in tables of course the length of the side is unity, and such tables have been calculated by Molesworth and Templeton as I have shown above.

As to being enamoured of the practice of making the chord pitch in unequal circles equal, the statement is absurd, as I wrote with the special object of ventilating such unsound practice; I think any one will agree that the suggestion of Millwright is a good one. It would save endless bother and confusion to have one uniform system of wheel teeth throughout the country. Thanking you for the insertion of this letter.

I am, Sir, yours truly,
DISCIPULUS.

To the Editor of Engineering.

SIR,—Your correspondent "Omicron," in last Friday's ENGINEERING, quotes a few audacious extracts from Burgh's "Practical Rules for Steam Engines and Boilers," and he shows how false and contradictory the assertions are, as regards pitch and circumference, &c.

It is now almost ten years since you performed the good and charitable service of reviewing a work by the same author, and such of your readers as may wish to look at your article can find it in vol. xxiii, ENGINEERING, p. 141; it is worth reading, as it sets forth some of the most preposterous points of the misleading rules and information (?) contained in the book. Again, on page 163 of the same volume will be found a correspondent's satirical letter suggesting additional useful rules (?) and recommending their adoption, &c. How misleading such books are!

"Millwright" complains of the want of uniformity as regards shape of teeth of wheels as made by different makers for same pitch, and suggests "that some influential engineer will take up the subject of the form of teeth of wheels, as Sir Joseph Whitworth did as regards the form and pitch of screws."

The problem of arriving at a uniform shape and pitch for screws was a far easier matter than determining a uniform shape for teeth of wheels, or long ere this it would have been accomplished.

There are two shapes (proper) for faces of the teeth of wheels, the involute and the epicycloidal. Involute teeth have the property of gearing correctly with any wheel of same pitch and proportions as to depth, thickness, &c., so that a universal rule could be established for their manufacture. But the shape of these teeth is such that in working they mutually grind each other away, and have a tendency to get themselves into too shallow gear by reason of their *sloping faces* forcing centres of shafts further apart by consequent wear of brasses, &c.; they possess great strength, however, as they are spread out at the roots. These teeth have, therefore, defects which militate against their general adoption.

The epicycloidal shape will gear correctly with a mate made to suit, but will not gear with another of same pitch differing much in diameter from such mate. This is a great disadvantage, but, on the other hand, epicycloidal teeth perform their functions by *rolling* contact, not by *sliding*, as in the case of the involute.

Now Professor Willis, about thirty-eight years ago, went into the matter of uniformity of pitch and shape of teeth of wheels, and invented the "*odontograph*" for finding the centres for describing approximate circular curves for flanks and faces of the teeth, but the shape of tooth described being allied to the involute, it did not come into general practice.

Yours truly,
R. HARTLAND.

Cork, January 25, 1887.

A NEW SAFETY MINING CARTRIDGE.

To the Editor of Engineering.

SIR,—This invention, described in your issue of January 21, 1887 (page 67), appears to be based upon erroneous chemical data.

The inventor claims (see Gluckhauf, No. 16, 1886) that in a cartridge 180 mm. long and 25 mm. diameter, whose cubical contents are 90 cm.^{3}, the production of hydrogen from 12 grammes of zinc will be 3.37 m.^{3}, and the pressure 37,000 atmospheres.

According to formula $Zn+H_2SO_4$, 65.2 grammes of zinc will produce 2 grammes or 22.32 litres of hydrogen; 12 grammes of the dust will contain about 10 grammes of zinc and the volume of hydrogen produced will be 3.423 litres. If this volume be compressed into a space of 90 cm.^{3}, the pressure will be 38,000 and not 37,000 atmospheres.

It is somewhat extraordinary that the description of this invention and the above-named inaccuracy has appeared in many English and foreign papers without correction.

Yours faithfully,
M. WALTON BROWN.

Coal Trade Office, Newcastle, January 24, 1887.

FIRE BOATS.

To the Editor of Engineering.

SIR,—Will you kindly insert the following in reference to the communication published in ENGINEERING of the 14th instant on "Fire Boats," by Mr. William Cowles, and more especially to rectify the following paragraph which appears in that communication, namely:

"As far as known to the writer, it was in the year 1885 that the first floating fire engine, self propelling and of high power, was designed and built, this was the Seth Low, of the Brooklyn Fire Department."

We will now give particulars of some self-propelling steam fire engines we ourselves have built. In 1852, we altered a floating manual engine worked by 120 men to steam power. She had two locomotive boilers and was self-propelling; this was probably the first self-propelling floating steam fire engine ever made. Of floating steam fire engines made since then we will give three types; first the D floating fire engine made for the London Fire Engine Establishment in the year 1855. She is 105 ft. long, 14 ft. 6 in. beam, 7 ft. depth, draught 4 ft.; the fire engine delivers 1100 gallons per minute at high pressure, and the boat has a speed of 10 knots. This is a good specimen of what we did thirty years ago, and is at the present time in regular use. The second type we give is the Hooghly, supplied by us to the Council of India, for use at Calcutta, on the river of which she bears the name. She was built in 1865, is 120 ft. long, 16 ft. beam, has a depth of 8 ft., and a draught of 4 ft. 6 in., her speed on the measured mile was 13 knots, and she delivered 2000 gallons per minute, and at her official test worked six 1¾ in. jets. The third type is a smaller boat than the above, and such as we have lately supplied to Rio de Janeiro and to Bristol; the length is 51 ft., beam 11 ft., depth 6 ft. draught, 3 ft., speed 10 knots, gallons delivered per minute 1100. The boiler is of our quick steaming type, steam of 100 lb. having been raised in 8 minutes 52 seconds, this being good time for a large boiler of this description.

There are other floating steam fire engines which we could enumerate of various descriptions. One type we may mention of which we have lately supplied four to the Metropolitan Fire Brigade, in accordance with the requirements of the chief officer, Captain Shaw. These are placed on barges 60 ft. long by 14 ft. wide, by 3 ft. 6 in. deep, and draw only 18 in. water, the pumps delivering 1100 gallons per minute. They are not self-propelling, but are kept particularly light for shallow water, and are tugged into position by independent boats.

The above will show that floating fire engines, self-propelling, and of high speed and power, have been made thirty years previous to the date given in the account by Mr. Cowles as the limit of his knowledge.

The paper is an interesting one, but the draught in all the American fire boats, ranging from 7 ft. 6 in. to 9 ft. 9 in., would give a designer considerable latitude as to the boiler and engine to be used in a fire boat, as would also the prices given in the comparative table as paid for these respective fire boats.

We are, yours truly,
SHAND, MASON, and Co.

Upper Ground-street, Blackfriars-road,
London, January 25, 1887.

JOINTS FOR CYLINDRICAL BOILERS.

To the Editor of Engineering.

SIR,—Your correspondents, David Rollo and Sons, in your issue of January 21, are surely under a misapprehension regarding the strains set up in a boiler plate under pressure, judging from the calculations contained in their communication.

They deal with a diagonal joint much in the same way as they might with a longitudinal joint, forgetting that though in the latter case the stress is, broadly speaking, simply the transverse stress on the plate, in the former case it is the resultant of the longitudinal and transverse stresses; and the supposed greater strength of the diagonal joint is due to the fact that in a plain cylindrical shell the longitudinal unit stress is always exactly half the transverse, and that the resultant unit stress will be somewhere between them, depending upon the obliquity of the joint.

Thus in the case of a joint inclined at 45 deg. to the axis of the boiler, this resultant unit stress will be 1.58 times the longitudinal, or 0.7 times the transverse, and will make an angle of 72 deg. with the joint, and a boiler so constructed should be, theoretically at least, 1.26 times as strong as with a longitudinal joint of same proportions. The greater the angle of the joint, the greater will be the gain in strength until in the limit the angle becomes 90 deg. and the joint becomes a transverse joint, and the ultimate strength of a diagonal joint is that of a transverse joint of same proportions.

In one sense the objection raised by Lloyd's surveyors, that the joint might by a slight alteration of the pitch be made actually stronger than the solid plate, does not hold good, and in another sense it does. No joint, however elaborate, either of boiler or girder work, can be made to resist as great a tensile stress as the solid plate out of which the joint is made, unless in some way as was proposed by Fairbairn many years ago, where the ends of the plates forming the joint were to be rolled or forged thicker than the body of the plate. By a process well known to any one who has ever designed a properly proportioned girder, a joint can theoretically be made to approximate as nearly as may be required to that of the solid plate, but without ever reaching it, and so it could be done also in a steam boiler, but that considerations of a practical nature forbid, and in this sense the objection is good. But a double strip butt joint has a strength of 76 per cent. of the solid plate. The longitudinal unit stress in a cylindrical shell is only one-half the transverse stress, and therefore a transverse double butt joint is 26 per cent. stronger than the solid plate longitudinally. Also, if what I have stated above is correct, viz., that a diagonal joint at 45 deg. makes the boiler 1.26 times as strong as a similarly proportioned longitudinal joint, and that a longitudinal joint has 76 per cent. the strength of the solid plate, it follows that the diagonal joint makes the boiler $1.26\times76=95.76$ per cent. of the strength of the solid plate, and by slightly increasing the angle of the joint, the strength could be brought up to or over that of

the solid plate, and in this sense the objection requires some qualification.

If in any case it should happen that the transverse and longitudinal unit stresses were equal, the diagonal joint would of course give no better results as regards strength than the longitudinal. In this case the boiler would be uniformly strong in every direction with joints of the same proportions.

Yours truly,
ROBERT COEY.

Inchicore Railway Works, Dublin.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the letter of Messrs. David Rollo and Sons in your last issue, diagonal seams for boiler shells are not new. The strength of a diagonal seam is just one-third greater than the strength of the same seam would be if longitudinal. If Messrs. Rollo will recalculate their proposed joint they will find that the plate strength, if in a longitudinal seam, would be 63⅓ per cent., and adding one-third of that we get 84.4 per cent. for the diagonal seam instead of the 90 per cent. claimed for it by Messrs. Rollo. The rivet strength is 79.2 per cent. if longitudinal, adding one-third we get 105.6 per cent. for the rivet strength of the diagonal seam. These increased percentages are of course in comparison with the longitudinal shell section.

If Messrs. Rollo would put in two rivets less in the diagonal seam, the pitch would then be 4.17 instead of 3.75, and with the rivets the same diameter, viz., 1⅜, the strengths would come out

Plate, $67.02 \times \frac{5}{6} = 89.36$ per cent.
Rivets, $71.2 \times \frac{4}{5} = 94.9$,,

or practically 90 per cent., and a little to spare in the rivets. Perhaps this is the division intended by Messrs. Rollo, and the one rivet more in the length of the seam may be a clerical error.

Lloyd's surveyor seems to be staggered at the possibility of a diagonal joint being stronger than the solid plate; but this only means that the boiler would burst longitudinally through the solid plate in preference to following a longer line of fracture coinciding with the diagonal seams.

By increasing the rake of the seam to extend 2 ft. in circumference for 1 ft. longitudinally, the bursting strength of the shell would be $\frac{5}{6}$ of that due to the same seam longitudinally. It is in this direction that Lloyd's surveyors proceed in their supposed demonstration of the fallacy of Messrs. Rollo's calculation. It is, however, Lloyd's who are wrong. Extend their illustration to this excessive rake, retaining the last described proportions, and the strength would be

Plate, $67.02 \times \frac{5}{3} = 111.7$ per cent.
Rivets, $71.2 \times \frac{5}{3} = 118.7$,,

This is a good deal stronger than the solid shell. We do not say with Lloyd's, "It is evident at once that these results are not correct." We say in this case the boiler will burst through the solid shell, and not along the raking seams. The Board of Trade, having no Treasury grant for experiments, are always on the grab to get wealthy manufacturers to stand the cost of experiments. In this case it must have been their object to convince Messrs. Rollo that the 90 per cent. claimed was an error. The experiment could not be required for their own information, because what we are now writing was shown to us at Whitehall twenty years ago, when the question of higher pressures was beginning to be discussed.

The simple formula given to us at that time was, If in a cylindrical boiler a seam rakes to run n circumferentially for one longitudinally the strength is thereby increased in the proportion of

$$\frac{2n^2 + 2}{n^2 + 2}.$$

This gives $\frac{4}{3}$ when $n = 1$ and $\frac{6}{5}$ when $n = 2$.

This applies to a cylindrical shell unstayed longitudinally. Longitudinal staying still further increases the strength of a raking seam, but the effect of unequal expansion is in the opposite direction, and perhaps the one may be set off against the other.

Messrs. Rollo and others claim that the 45 deg. diagonal joint is stronger than a similar longitudinal joint in the proportion of the square root of *two* to *one*, whereas, at that time, and we suppose now also, the Board of Trade officers maintained that the relative strengths were as four to three. We have since then come to see that the four to three is correct, and our experience will perhaps be now useful to Messrs. Rollo.

We are, Sir, yours faithfully,
January 24, 1887. BOILERMAKER AND SONS.

WATER AND SEWER WORKS AT WARSAW.—Some important public works which have been under construction for some time at Warsaw by Mr. W. H. Lindley, will be completed this coming spring. The works were commenced in 1882 and consist of water works for providing the city with a daily supply of 600,000 cubic feet of well-filtered water and with sewers measuring 58,000 ft. in length. The following articles required for the work were supplied from England: Stoneware invert lining, stoneware pipes, firebricks, steam engines and boilers, cocks, and sluice valves. It is expected that, according to Mr. H. Grant, the British consul at Warsaw, the work will be continued and extended, as the supply of water mentioned will only suffice for about half the present population of Warsaw, and the same may be said of the sewers. The *Board of Trade Journal*, from which we gather our information states that the field is now open for water and sewer fittings, taps, water-closets, syphons, gullies (street and yard), stoneware pipes and specials for house drainage (4 in., 6 in., and 8 in. in diameter), stoneware gullies, &c. Lead piping will also be required, but in this it is considered doubtful whether British makers will be able to compete.

CENTRIFUGAL PUMPS AT KHATATBEH, EGYPT.

CONSTRUCTED BY MESSRS. FARCOT AND CO., ENGINEERS, PARIS.

(*For Description, see opposite Page.*)

Fig. 14.

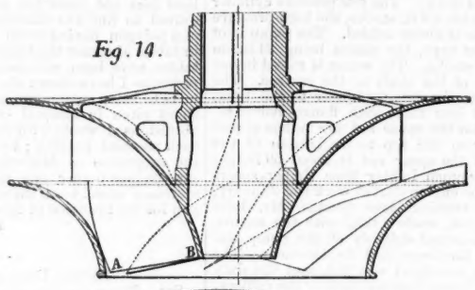
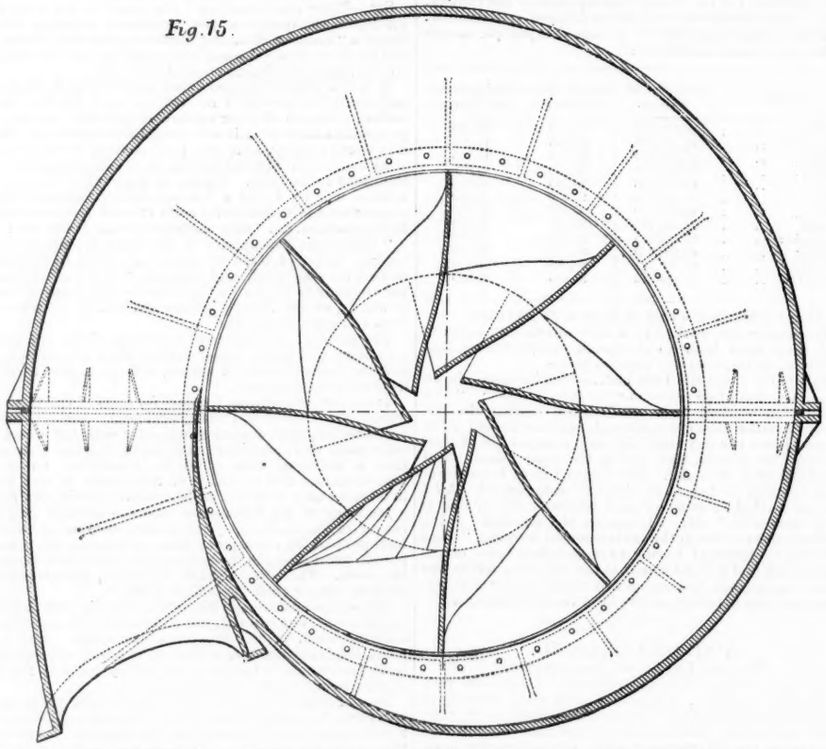


Fig. 15.



ARMSTRONG GUNS.

WE publish below a Table, which will be useful for reference, giving the particulars of the guns manufactured by Messrs. Sir W. G. Armstrong, Mitchell, and Co., of Elswick Works, Newcastle-upon-Tyne:

TABLE OF ARMSTRONG GUNS.

Gun.	Calibre.	Weight.	Total Length of Gun.		Length of Bore.		Weight.		Muzzle Velocity.	Total Energy.	Energy per Ton Weight of Gun.	Energy per Inch of Shot's Circumference.	Thickness of Wrought-Iron Plate the Shot is Capable of Perforating.
							Charge.	Projectile.					
in.	in.	tons	calibres.	in.	calibres.	in.	lb.	lb.	ft. per sec.	ft.-tons	ft.-tons	ft.-tons	in.
4.724	4.724	2.5	24	112.7	22	104.0	12	40	1680	783	522.0	53.1	7.0
4.724	4.724	2.2	35	165.3	33	156.6	16	40	2078	1,198	532.4	81 3	9.1
6.0	6.0	4.0	28	166.4	26	156.2	42	80	2060	2,354	538.5	125.7	11.6
6.0	6.0	4.5	32	192.0	30	180.0	45	100	1940	2,610	580.0	139.4	12.2
6.0	6.0	5.5	37	222.0	35	210.0	60	100	2146	3,193	580.5	170.5	13.5
7.0	7.0	7.0	28	196.0	26	182.0	60	120	2050	3,497	466.3	160.2	13.0
7.0	7.0	8.0	32	224.0	30	210.0	75	145	2020	4,075	479.4	186.6	14.1
7.0	7.0	9.0	37	259 0	35	245.0	80	145	2140	4,604	511.5	210.9	14.9
8.0	8.0	11.5	28	222 5	26	208.0	120	180	2177	5,915	514.3	236.9	15.8
8.0	8.0	12.5	32	256.0	30	240.0	120	200	2157	6,452	537.6	258.4	16.5
8.0	8.0	14.0	37	296.0	35	280.0	130	210	2236	7,280	520.0	291.5	17.5
9.2	9.2	19.0	28	257.6	26	238.7	175	320	2060	9,412	495.3	327.5	18.5
9.2	9.2	21.5	32	287.3	30	267.8	200	380	2035	10,923	508.0	380.1	20.0
9.2	9.2	24.0	37	340.4	35	322.0	230	380	2375	14,800	616.6	515.0	23.2
10.0	10.0	25.0	28	274.0	26	254.5	200	450	1910	11,383	455.3	364.2	19.5
10.0	10.0	27.0	32	320.0	30	300.0	270	470	2185	15,560	576.3	497.9	22.8
10.0	10.0	30.0	37	370.0	35	350.0	270	500	2213	16,979	566.0	543.3	23.8
12.0	12.0	43.0	28	331.0	26	307.5	330	700	2087	21,141	491.6	563.1	24.2
12.0	12.0	46.0	32	384.0	30	360.0	400	800	2117	24,861	540.4	662.2	26.2
12.0	12.0	51.0	37	444.0	35	420.0	450	850	2205	28,665	562.0	763.6	28.1
16.25	16.25	93.0	28	455.0	26	422.5	850	1800	2106	55,377	595.4	1088.7	33.5
16.25	16.25	110.0	32	520.0	30	487.5	900	1800	2216	61,200	556.4	1203.2	35.2
16.25	16.25	127.0	37	601.3	35	568.75	900	1800	2295	65,745	517.6	1292.6	36.5
17.0	17.0	100.0	28	468.0	26	442.0	827	2000	1932	51,790	517.9	973.1	31.7
17.0	17.0	116.0	32	544.0	30	510.0	1000	2000	2190	66,512	573.3	1249.7	35.8
17.0	17.0	137.0	37	629.0	35	595.0	1000	2000	2255	70,520	514.7	1325.0	37.0

HORIZONTAL ENGINE WITH VARIABLE EXPANSION GEAR.

CONSTRUCTED BY MR. JOHN COCHRANE, ENGINEER, BARRHEAD.

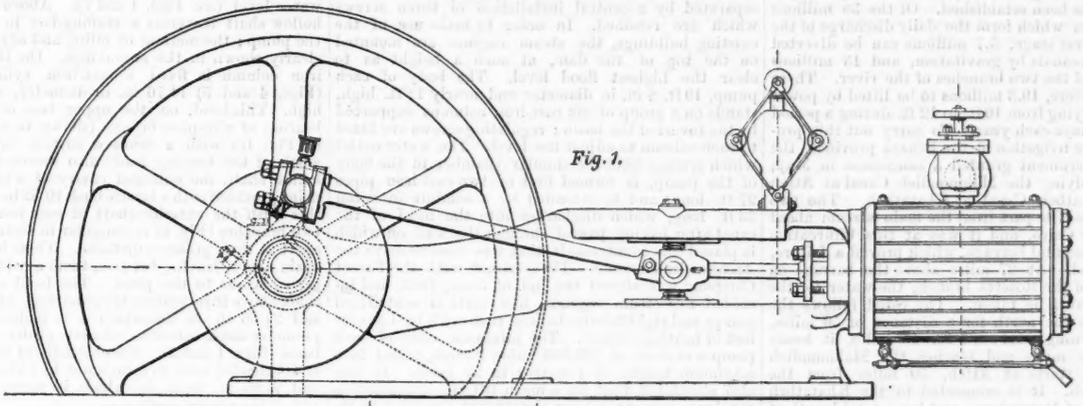


Fig. 1.

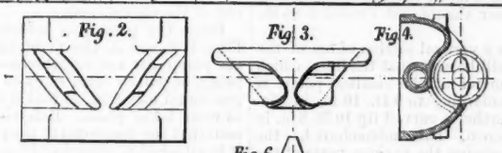


Fig. 2.

Fig. 3.

Fig. 4.

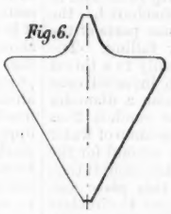


Fig. 6.

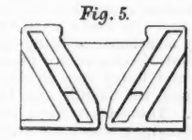
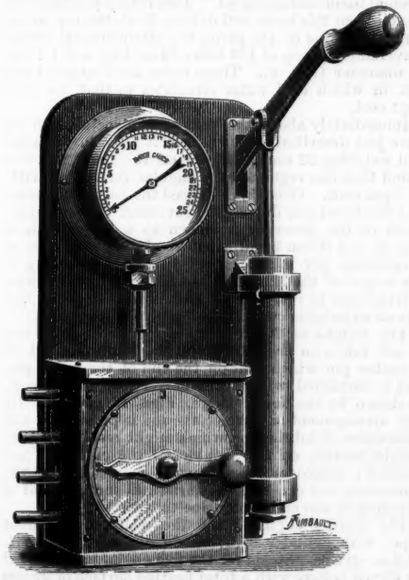


Fig. 5.

THE above engraving illustrates a horizontal engine constructed by Mr. John Cochrane, Barrhead, Glasgow, and shown at the late Edinburgh Exhibition. The cylinder is 9 in. in diameter by 18 in. stroke, and is fitted with an expansion valve regulated by a high-speed governor. The details of the valves, which are of the Bodmer type, are shown in Figs. 2 to 6. Fig. 2 is a view of the expansion face of the main valve; Fig. 3 shows the expansion valve; Fig. 4 shows a cross-section through the exhaust and steam ports of the main valve, and an end elevation of the cut-off valve; Fig. 5 is a development of the main valve expansion face; and Fig. 6 is a similar view of the expansion face of the cut-off valve. These engravings show all the parts of the two valves very clearly.

SMALES'S PNEUMATIC HYDROMETER.

SMALES'S pneumatic hydrometer is a handy instrument for measuring the depths of fluids. It is capable of being applied in many different situations. For



instance, it may be used in a ship to ascertain the amount of water in the different compartments, and for this purpose it is fixed in the chart-room or in the engineer's cabin, and enables the officer to sound each part of the vessel in succession without leaving his post. In a brewery it will indicate to the manager the amount of water in the well, in the cistern at the top of the building, and in the various tuns throughout the building. In the latter case the dial may be marked in gallons if it be preferred. Many other situations will suggest themselves to the reader in which an instrument which will measure the depth of liquids at a distance, without involving the trouble of a visit to the spot, would be most convenient and economical of labour.

The principle on which the hydrometer acts is exceedingly simple. A pipe, open at the lower end, is placed in each tank or compartment to be measured. The other end of this pipe is led to an air-compressing pump provided with a pressure gauge. The pump is worked and air forced into the pipe until the whole of the liquid is ejected from it, and the air escapes at the lower end. A reference to the gauge shows the pressure required to effect this, and this amount may be readily converted from pounds per square inch into the equivalent head of water. Or better still, the gauge may be marked in feet of the liquid which is to be measured.

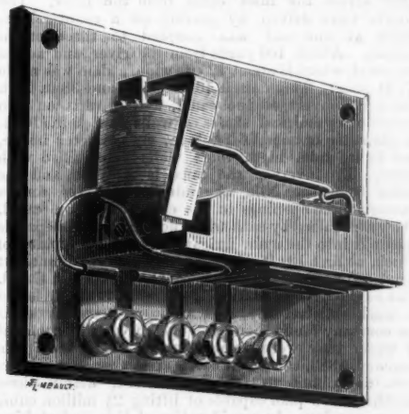
The illustration on the present page shows the instrument as constructed for sounding four vessels or compartments. The four pipes lead to a fourway cock by which any one may be placed in connection with the pump and the pressure gauge. The manufacturers are Messrs. W. Reid and Co., 45, Fenchurch-street, London.

A PATENT SLIP AT MANILA.—A work that should prove of considerable benefit to the shipping community has lately been completed at Cañacoa (Cavite), Manila. This is a new patent slip, the property of the Manila Slip Company, Limited, which has recently been tried and found very satisfactory. The company, it is stated in a communication from Her Majesty's consul to the official journal of the Board of Trade, "are now prepared to undertake the repairs of vessels and other shipbuilding work under the supervision of an engineer and shipbuilder from the Clyde." The following are the principal dimensions of the slip: Length, 820 ft.; length of cradle, 270 ft.; width inside rope-rods, 36 ft.; inclination, 1 in 18; depth at outer end (h. w. to rails), 26 ft.; width of ways (centre to centre of side rails), 27 ft. The capacity is about 2500 gross tons, according to draught and build of vessel, and working capacity of hydraulic hauling gear is 2000 tons. The rise and fall of extreme springs at Cañacoa is 5 ft. 6 in. and average neaps are 3 ft. 9 in. The site of the works is in a well-sheltered bay, where work can be carried on afloat in any weather, and the repairing shops are said to contain all necessary appliances fo repairing all classes of steamers and sailing ships.

THE CUNYNGHAME, WOODHOUSE, AND RAWSON CUT-OUT.

MESSRS. WOODHOUSE AND RAWSON'S magnetic cut-out, which we illustrate in the annexed engraving, is designed to cut a lamp out of circuit should the feeding mechanism refuse to act; it thus prevents the destruction of the fine coil of the lamp, the insulation of which is usually damaged under the circumstances, by the excess of current sent through it.

The cut-out has four terminals, two form the ends of the coil on the electro-magnet, which is inserted in the main circuit of the lamp, so that the entire



current has to pass through it; the remaining pair are connected to the lamp terminals and also to two mercury cups in the body of the instrument. So long as the current is flowing across the arc of the lamp, the magnet is excited and holds its armature in a vertical attitude. But should the arc fail the armature will fall, and will drop the fork it carries into the two mercury cups; it will thus establish a short circuit between the terminals of the lamp, and the current will flow past it to the next.

IRRIGATION IN EGYPT.

WE referred a few weeks since* to an interesting paper read before the French Society of Civil Engineers, by M. Brüll, on the irrigation of the province of Béhera, and we are now enabled by the courtesy of the author to publish a more extended account of the works carried out there by French engineers, to supplement the insufficient appliances previously existing for raising water from the Nile in this district. In the old time, thanks to the complete system of irrigating canals that once existed, at least 20,000,000 hectares of land were under cultivation in Lower Egypt, but this area has now fallen to one-eighth of that amount, owing to gradual alterations in the physical conditions of the river, to works badly conceived and carried out, and to the neglect in maintaining the old systems. The rapid decrease in area, and deterioration in value of cultivatable lands, has long been a source of alarm to the Egyptian Government, whose resources were wholly inadequate to meet the urgent necessities of the case, while for a long time, such means as were at their disposal were squandered by incompetent or self-interested advisers. Thus, for example, the great barrage at the bifurcation of the Damietta and Rosetta

* See ENGINEERING, vol. xlii., p. 579.

branches of the Nile, executed at a vast expense, proved to be a gigantic failure.

Later efforts have resulted in more useful works, and at present something like a system, although only a partial one, has been established. Of the 38 millions of cubic metres which form the daily discharge of the Nile at its lowest stage, 5.7 millions can be diverted into irrigation canals by gravitation, and 13 millions are left to feed the two branches of the river. There remains, therefore, 19.3 millions to be lifted by power to a height varying from 10 ft. to 12 ft. during a period of 120 or 130 days each year. To carry out this programme for the irrigation of the Béhara province, the Egyptian Government granted a concession in May, 1880, for supplying the Mahmondieh Canal at Atfeh and the Khatatbeh Canal at Khatatbeh. The two branches of the Nile part from the main stream about 16 miles above Cairo, and it was at this bifurcation that the monumental barrage, which proved a failure, was constructed. At 27 miles above the barrage on the left bank of the Rosetta branch, the water for the Khatatbeh branch is taken. The canal follows the valley towards the north for a distance of 50 miles, then after turning westward for 15 miles, it heads north for five miles and reaches the Mahmondieh Canal, which starts at Atfeh, 50 miles from the Rosetta branch. It is connected to the Khatatbeh near the town of Damanhour, and has a total length of about 44 miles. The concession of 1880 comprised the extension and alteration of the installations already existing at Atfeh, of a new hydraulic station with elevating machinery, and all the necessary plant for maintenance and repairs.

We propose to describe for the present only the Khatatbeh station on the left bank of the Nile. The company owning the concession placed themselves in the hands of English engineers, who attempted to solve the problem by means of ten Archimedean screw wheels, each 12 ft. 1 in. in diameter and 36 ft. 10 in. long. These wheels were placed parallel to each other across the inlet canal from the river. The wheels were driven by gearing off a countershaft, which at one end was coupled to three steam engines. About 100 yards from the river, and across the canal, which is about 125 ft. wide, a dam was made 177 ft. long. This dam is 16 ft. thick and 38 ft. high above the invert of the canal, and it rests on two ranges of cylindrical shafts or wells each 9 ft. 10 in. in diameter outside, 6 ft. 7 in. in diameter inside, and 13 ft. 4 in. high, these wells being filled with béton. The invert of the canal is of béton, and the water from the Nile was admitted to the screws through three openings in the end wall of the canal. The water raised by each wheel flowed through separate openings into the main irrigation canal, the width of which, at first 131 ft., is gradually narrowed until at about 600 yards it connects with the Khatatbeh Canal. This extensive installation, completed in 1882, failed to work satisfactorily, and after numerous attempts the company found themselves unable to lift the amount of water they were under contract to deliver. In January, 1883, the Béhara Irrigation Company undertook to submit to the Government, within three months, a new plan capable of lifting 2½ million cubic metres per day. In consideration of this undertaking the period of the concession was extended from twenty-five to thirty-five years, and the price for water was increased. During November of the same year designs and tenders from various manufacturers were invited, and amongst them one from Creusôt and another from Messrs. Farcot and Co. were selected, and submitted to a committee of three French engineers, who recommended the adoption of Messrs. Farcot's design, which was elaborated to fulfil the following conditions.

The water has to be raised through varying heights according to the Nile level, the range being from 20 in. to 10 ft., the daily discharge to be 2½ million cubic metres in 23 hours; the cost of fuel being of great importance in a country where fuel is very dear, the utmost attention to economical working and high efficiency were of primary importance; the existing buildings and foundations were to be utilised as far as possible; and the pumping machinery was to be placed at such a level as to be out of danger in the time of flood.

The system proposed by Messrs. Farcot to fulfil these various conditions included the use of five centrifugal pumps each revolving on a vertical axis, and each driven by a separate engine, the arrangement being shown by the illustrations which we give on our two-page engraving this week, and on pages 84 and 92. Each of these machines, illustrated by Figs. 1 and 7,* consists of a centrifugal pump giving for a height of 10 ft. a discharge of 6 cubic metres (212 cubic feet) at a speed of 32 revolutions per minute, the vertical axis of the pump carrying at the top a crank to which the connecting-rod of the engine is directly connected. The fan or disc of the pump has an outside diameter of 12 ft. 5.6 in.; the circumferential speed at 32 revolutions per minute (the speed for the 10 ft. lift) is therefore not more than 21 ft. per second. Three of the five pumps are placed in that part of the basin where four of the Archimedean screws were fixed, and the other two are in another part of the basin where were three other screws. These groups are therefore separated by a central installation of three screws which are retained. In order to make use of the existing buildings, the steam engines are mounted on the top of the dam, at such a height as to clear the highest flood level. The body of each pump, 19 ft. 8 in. in diameter and nearly 12 ft. high, stands on a group of six cast-iron columns supported by the invert of the basin; regulating screws are fitted to each column to adjust the level. The water outlet which springs from the annular chamber in the body of the pump, is formed first of two cast-iron pipes 27 ft. long, and is extended by a conduit in béton 33 ft. long, which discharges into the head of the canal after having passed through the wall on which is placed the countershaft that was used to drive the Archimedean screws. The contract with the Farcot Company was signed the 2nd of June, 1883, and included five steam engines, five vertical centrifugal pumps and eight tubular boilers, each with 1884 square feet of heating surface. The minimum duty of each pump was fixed at 500,000 cubic metres, raised to a maximum height of 3 metres in 23 hours. It was also stipulated that on a mean lift the consumption per horse-power per hour should not exceed 3.85 lb. of good English coal.

Fig. 7, on page 84, is a vertical section of one of the pumps. From this it will be seen that the inlet, which is 6 ft. 10.6 in. in diameter at the smallest point, is trumpet-mouthed, it enlarging to 9 ft. 10 in. in diameter, while there is further a curved lip 10 ft. 8 in. in diameter over all, as shown. This embouchure has the most suitable form to receive the various parts of the current whether rising, horizontal, or falling. The inlet opening not only narrows gradually to a throat as explained above, but within it is an inverted cone which, rising in the centre, passes from a diameter of 11.8 in. to 23.6 in. The annular conduit thus doubles on itself and directs the rising column of water which attains a speed of about 6 ft. per second for the normal discharge of 6 cubic metres. This conduit then swells out slightly, and the fan at this place surrounds the current of water which begins to circulate in the movable part of the pump. The fan is 4 ft. 8.10 in. high, and the form of the blades is shown by Figs. 14 and 15, on p. 92. The capacity available for the water is a solid of revolution generated by a rotation around the axis of two generatrices, one internal and the other external. These two meridional curves, concave below and parabolic in form, rise almost vertically at their lower part, and then curve outwards almost to the horizontal. They are connected by eight helicoidal wings springing from the cone of the lower base of the disc; these wings are curved spirally backwards through an angle of about 60 deg.

Near the axis of rotation the wings are set out in curves deduced from the resultants of the centrifugal and tangential velocities; but in order to communicate better to the water the movement of rotation of the disc, and thus avoid giving to it a surplus velocity beyond that required for the height of lift, the wings approximate more and more closely to the radial lines (see Figs. 14 and 15). As soon as the water by the action of the fan has acquired a sufficient tangential velocity, the energy thus acquired is utilised by increasing the area of the chamber. This means of effect is commenced in the annular chamber of the pump, and is continued to the discharge outlet. This annular chamber has more than 42 ft. development. It commences with a small section, which is gradually increased both in height and width, the area being enlarged almost proportionately to the amount of water received from the pump, as shown on Fig. 11. The chamber is extended by a tangential mouthpiece 4 ft. 3 in. in diameter, and in which the velocity of current ought not to exceed 10 ft. 6 in. per second. To this opening is attached the discharge conduit 50 ft. long, this conduit changing gradually from a circular to a rectangular form 8 ft. 3 in. high by 13 ft. wide; the velocity of discharge is here reduced to less than 2 ft., and the opening is controlled by a sluice valve.

That part of the body of the pump which includes the annular chamber is terminated above and below by two circular flanges about 4 ft. 6 in. apart. To the lower flange is bolted a large conical chamber in one with the inlet tube. As will be seen, this chamber is carried by the six adjustable columns referred to above. The disc revolves within this chamber, and between the inner side of the latter and the outside of the former, there is an annular space of nearly 10 in. To the upper flange of the chamber is bolted the domed top of the pump which supports one of the shaft bearings.

We may now proceed to consider some of the details of the installation. The vertical axis of the pump coincides with that of the engine shaft. If this shaft had been extended down to the invert the footstep would have been immersed and lubrication would have been very difficult. The Fontaine system of pivot largely used for turbines, was therefore adopted. The lower part of the pump shaft is made hollow to admit a column or support solidly attached to the invert, and serving as a bearing above the level of the pump itself, and nearly 5 ft. above the highest probable water level (see Figs. 1 and 7). Above the disc the hollow shaft traverses a stuffing-box in the dome of the pump; the method of oiling and adjusting this is clearly shown in the engravings. On the top of the iron column is fixed a cast-iron cylindrical head (Figs. 4 and 5) 14.76 in. in diameter, and 17.72 in. high. This head, on the upper face of which is a bearing of phosphor-bronze (shown to a larger scale in Fig. 10) with a concave surface supporting the whole of the turning load, also serves to centre the hollow shaft, the enlarged cavity of which is at this point provided with a bronze bush 10.82 in. deep. Above this bush the exterior shaft of cast iron divides into two branches (Fig. 6) rectangular in section and 24 in. apart at their greatest distance. These branches meet again above, leaving between them a wide opening for giving access to the pivot. The head of the hollow shaft above this opening is cylindrical, 24.80 in. high, and 21.66 in. in diameter; it is inclosed in a large plummer block bolted to a heavy girder spanning the basin (Figs. 1 and 3). This cylindrical head is hollow and threaded so as to form a nut 15.75 in. in diameter, and 21.66 in. deep, in which is screwed the lower end of the engine shaft.

Below the point just referred to will be seen, in Figs. 1, 4, and 5, the pivot on which the weight of the pump disc and its attachments is borne, the pivot being, as will be seen, screwed and fitted with a deep gun-metal lock-nut, so that it is adjustable vertically as wear takes place. Referring to Fig. 5, it will be seen that the lower end of the pivot is recessed, and to it is attached a phosphor-bronze bearing of the form shown to a larger scale in Fig. 8. Between this bearing, which of course revolves at the same speed as the pump, and the lower fixed bearing, which we have already mentioned as being carried on the top of the fixed central column, are placed three loose discs, the upper and lower ones bi-convex and made of hard steel, and the middle one bi-concave, of phosphor-bronze. These three discs (only one disc is shown in our engraving), which are entirely free, are intended to distribute and equalise between them any inequality of friction, and to divide uniformly the work to be done. In the latter case the lower disc would have only one-fourth the speed of rotation of the pump, the middle disc one-half, and the upper one three-fourths of its velocity, so that the relative speed of the four frictional surfaces would be only one-fourth of that of the shaft.

Although these contact surfaces are of such a form as to tend to centre the free discs they are surrounded with a gun-metal sleeve 11.8 in. long. The diameter of the discs is 8.66 in., giving an area of 58.9 square inches, and deducting the surface lost in the oil passages the weight upon them (equal to 50 tons) is about 2270 lb. per square inch. The lubricating arrangements are shown in Figs. 8 to 10, and it will be seen that on each of the four rubbing surfaces four oil chambers are cut radiating from the centre to the circumference, and four other grooves between the former run from the circumference towards the centre.

The gun-metal sleeve surrounding the discs is pierced with numerous holes. All these parts are contained in a round basin containing oil. Two rotary pumps draw the oil from this basin and deliver it at the top of the central opening of the pivot, the oil during its circuit traversing a group of 153 tubes 24 in. long and 1.18 in. in diameter (Fig. 6). These tubes are contained in a box in which cold water circulates so that the oil is kept cool.

Immediately above the part of the installation we have just described, a flywheel 22 ft. 3 in. in diameter and weighing 22 tons, is keyed on the shaft, and it is found that this regulates the angular velocity to within 3 per cent. Over this is placed the engine eccentric and the bevel gear driving the governor. The arrangement of the governor is shown to a larger scale in Fig. 2, and it can be adjusted to give any number of revolutions per minute, from 16 to 42, according to the height of the lift. The governor is provided with driving gear to rotate it at two different speeds and has an adjustable counterweight.

The weight of the connecting rod at the large end is not taken on the shoulder of the crank-pin, but on a centre pin which runs on the end of the crank-pin, and is furnished with means of vertical adjustment, as shown by the detail views, Figs. 12 and 13. By this arrangement any sag of the rod is prevented, and difficulties of lubrication which might result from the weight resting on the shoulder of the crank-pin are avoided; moreover, the plane of movement of the connecting rod can be kept horizontal independent of any drop of the main shaft due to wear.

The Corliss engine is of the well-known Farcot type, with cylinder 39.37 in. in diameter, and 5 ft. 10.8 in. stroke. Steam for the five engines is provided by eleven boilers with a total heating surface of 22,200 square feet. Since its completion the installation has been working with success, giving a return of 65 per

* Figs. 1 to 6 are on the two-page plate; Figs. 7 to 13 on page 84; and Figs. 14 and 15 on page 92.

cent. of the indicated horse-power in power utilised. When the tests were made from which this result was deduced the pumps were working under the disadvantage of a greater lift than was anticipated when they were designed. In conclusion we have to acknowledge our indebtedness to the *Portefeuille Economique des Machines* for the engravings we have reproduced.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

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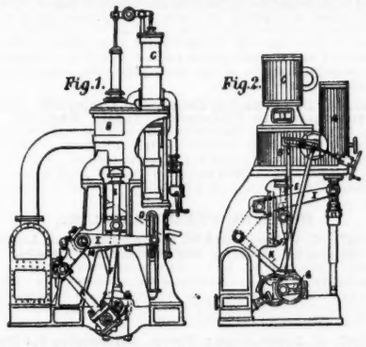
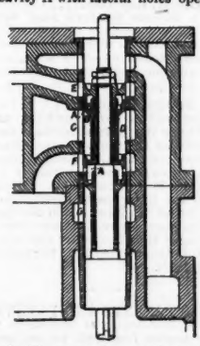
STEAM ENGINES.

12,262. G. Sellers, Batley, Yorks. Improvements in Steam or other Fluid Pressure Engines. [8*d.* 9 *Figs.*] October 14, 1885.—Fig. 1 represents a triple-cylinder expansion engine constructed according to this invention. The high-pressure cylinder A and the intermediate cylinder C are arranged tandem fashion, and their pistons are mounted on the same piston-rod D. The piston-rod E of the low-pressure cylinder B is connected directly by the rod F to the crank G on the crankshaft H, whilst the piston-rod D of the other cylinders is indirectly connected to the same crank by the bent power-gaining lever I and rod K. The lever I is centred at L to the framing M of the engine. Fig. 2



shows a similar arrangement with the exception that the low-pressure cylinder B and the intermediate cylinder C are arranged tandem fashion, their pistons being mounted on the rod E, which is directly connected by the rod F to the crank G, whilst the piston-rod D of the high-pressure cylinder A is indirectly connected to the same crank by the lever I and the rod K. The piston of the high-pressure cylinder A is arranged to travel in the reverse direction to that of the pistons of the cylinders B and C. This invention further relates to an automatic tripping gear for application to expansion valves in order to expedite and facilitate the action of the governor in varying the cut-off. (*Sealed October* 19, 1886).

12,614. R. Matthews, Hyde, Chester. An Improvement in Piston Valves for Steam Engines. [6*d.* 1 *Fig.*] October 21, 1885.—This invention relates to a construction of piston valve combined with a relief valve, whereby, while the piston valve itself accurately fitting its cylindrical case is covering a port, provision is made for the escape of water from the covered port. In the piston part of the slide is formed a cavity A with lateral holes opening outwards at



the periphery, and with an annular opening and valve seating on that side of the piston which is presented towards the exhaust passage C or G. To this seating is fitted an annular valve B which is pressed by a spiral spring D surrounding the valve rod. When the piston part of the slide is covering the port E or F, any water under pressure that may be present in the port can pass through the lateral apertures into the cavity A, and escape thence into the exhaust compartment of the slide case by opening the valve B in opposition to the spring D. (*Sealed October* 15, 1886).

12,963. S. G. Browne and W. Boby, London. Improvements in Direct-Acting Steam Engines. [1*s.* 1*d.* 13 *Figs.*] October 28, 1885.—The improvements relate more particularly to duplex pumping engines. When these engines are required to work in duplex, the controlling supplemental valves are actuated each from the piston-rod of the opposite engine; when working independently, each is actuated from its own piston by means of suitable connecting gear. The expansion valves are worked from the piston-rods of their own cylinders. Suitable provision is made either for a fixed or variable amount of lost motion, as may be required, in the traverse of the main and expansion valves. (*Sealed December* 21, 1886).

13,391. H. J. H. King, Newmarket, Gloucester. Improvements in Compound Steam Engines. [8*d.* 6 *Figs.*] November 5, 1885.—This invention has for its object to avoid a dead centre with a single crank. As there is a continuous acting power on the crank-pin the motion is much steadier than in the ordinary single crank compound engine. The piston-rods of the high-pressure and the low-pressure cylinders are connected to a connecting-rod shaped like a bell-crank which is common to both. The high-pressure piston-rod is steadied by a guide which is part of the slide block. The crankshaft is placed above the centre line of the low-pressure cylinder to reduce the friction on the slide bars. When it is advantageous to have the crankshaft as high as possible, the connecting-rod may be reversed and the crank placed as high as the high-pressure piston-rod. A T-shaped connecting-rod may be substituted for the bell-crank. In this case the slide blocks are rigidly fixed to the cross-head, which also forms a guide to the piston-rods. Links connect the piston-rods with the tails of the connecting-rod. This invention was fully described and illustrated in ENGINEERING, page 640, December 24, 1886. (*Sealed November* 12, 1886).

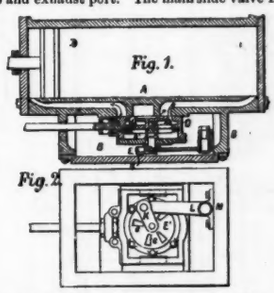
13,937. H. W. Garratt, London. An Improvement in the Expansion Links of the Valve Gear of Locomotive and other Steam Engines. [8*d.* 5 *Figs.*] November 14, 1885.—The improvement consists in the prolongation of the expansion links, and of the slot therein, to an extent beyond that necessary to admit of the engine being put into full forward or full backward gear, so that when the engine is "blind" in full gear, the valve covering the steam port through which steam is required to pass in order to start the engine, may be pushed backward sufficiently to uncover or partially uncover that port by lowering or raising the links beyond the full gear position. (*Sealed November* 19, 1886).

14,574. J. Black, Auchentoshan, Dumbarton, N.B. Improvements in the Construction of Steam and other Motive Power Engines of the Horizontal and Inclined and Vertical or Table Class. [1*s.* 1*d.* 9 *Figs.*] November 27, 1885.—The improvements consist of a rocking lever pivotted at one end upon a fixed centre, and at, near, or towards its other end, connected, either through or without the employment of a parallel motion, to the piston-rod or trunk of the engine; the motion so obtained is transmitted by a connecting-rod to the crankshaft to translate it into rotary motion. (*Accepted December* 14, 1886).

14,680. W. H. Martin, Flushing, Holland. Improvements in Auxiliary Starting Gear for Steam and other Engines. [8*d.* 3 *Figs.*] November 30, 1885.—The improvements consist in providing connections to each end of the cylinder or cylinders, whereby the motive fluid may be introduced at will simultaneouly to both sides of the piston or pistons. (*Sealed November* 26, 1886).

131. G. H. Corliss, Providence, Rhode Island, U.S.A. Improvements in Steam Engines. [11*d.* 9 *Figs.*] January 5, 1886.—The improvements relate to a special construction of stuffing-boxes, dashpots, and the governor. (*Sealed December* 21, 1886).

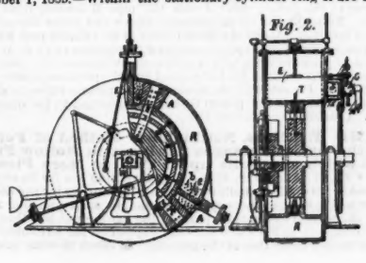
10,547. E. P. Alexander, London. (*C. Schmid, Chicago, Illinois, U.S.A.*) **Improvements in Slide Valve Mechanism for Steam Engines.** [8*d.* 9 *Figs.*] August 17, 1886.—This invention relates to slide valve mechanism in which the main slide valve is provided with escape ports and with a supplemental valve for opening and closing these ports in such a manner that there will be a free exhaust from the engine cylinder during the time that the steam therein is acting directly and expansively. The improvements consist in the mode of operating the supplemental valve. The engine cylinder A is provided with the usual steam ways and exhaust port. The main slide valve D is operated



by the valve rod in the usual manner. In the supplemental valve E¹ which is contained within the main slide valve, are formed radial apertures *e* corresponding in shape and location with the ports d^4 in the port plate D¹ in the main valve. The supplemental valve E¹ is fixed by a pin to a crank K which is connected with a rod L pivotted at M to the wall of the steam chest B. As the main slide valve D moves backwards and forwards, the rod L and crank K by reason of their connection with the supplemental valve E¹, cause this valve to partially rotate and thus open and close the ports of the main slide valve as required. (*Sealed November* 26, 1886).

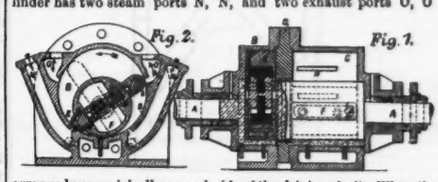
ROTARY ENGINES.

11,720. W. A. Barlow, London. (*G. Dietz and E. Tamsen, Hamburg.*) **Rotary Engines.** [8*d.* 10 *Figs.*] October 1, 1885.—Within the stationary cylinder ring R are three



pistons A fastened by radial arms T to a disc attached to the main shaft W. The connecting arms T are passed through and packed in the wall of the cylinder ring R by conical rings that rotate with the pistons during the operation of the machine. From the valve box X two channels *a* and *b* communicate with the cylinder, and can either of them be covered by the exhaust valve S. The steam coming from the boiler through pipe M enters the valve box *x* through the valve C. A slide E attached between the channels *a* and *b* to the cylinder ring R is lifted to allow the piston A to pass by means of a lever arrangement. As soon as the piston has passed the slide E, the slide descends and closes one section of the cylinder ring, and valve C is opened by another lever arrangement and kept open as long as steam is to be admitted. The steam rushes through the channel *a* into the cylinder ring between the slide E and piston A, and so forces the piston to move forward within the ring until it reaches the next slide E, where the same action is repeated. The exhaust steam at the other side of the piston A finds its exit through the channel *b* covered by valve S. (*Sealed October* 29, 1886),

13,190. T. Whitaker, Leeds. Improvements in Rotary Engines. [8*d.* 8 *Figs.*] November 2, 1885.—The chief improvements consist in the utilisation of the exhaust steam to carry the engine over the dead points. The high-pressure cylinder B and the low-pressure cylinder C face each other with open flanges ends abutting against a diaphragm D between them. The portion of the piston shaft A inside the cylinders is enlarged, and touches the entire length of the cylinders at one point in the circumference, thus preventing at this point the steam from passing between the shaft and the cylinder surface. Sliding pistons E and F arranged one in each cylinder at about right angles to each other, work in orifices cut through the driving shaft. The length of the projecting portion of each piston being pressed outward by springs, varies while revolving with the driving shaft. Each cylinder has two steam ports N, N, and two exhaust ports O, O

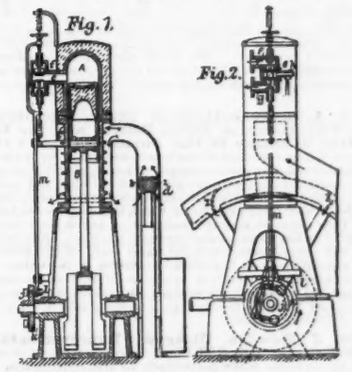


arranged symmetrically on each side of the driving shaft. When the high-pressure piston E has travelled as far as the exhaust port, the steam passes into the low-pressure cylinder, and this pressure is brought to bear on the pistons in both the high and low-pressure cylinders, forcing them both in the same direction, and therefore doing away with back pressure at that end of the high-pressure piston; and when the opposite end of the high-pressure piston begins to receive back pressure, the steam is admitted behind this end of the piston, and forces it forward, and more than balances the back pressure. There is therefore no dead point in this engine, as there is about equal pressure on the pistons during the whole of the revolution. This engine may be made to rotate in either direction by opening or closing the corresponding steam and exhaust ports. (*Sealed November* 9, 1886).

3916. J. Moss and W. Moss, Nottingham. Rotary Steam, Air, or Water Engines, Rotary Pumps. [1*s.* 1*d.* 5 *Figs.*] March 20, 1886.—The piston is arranged eccentrically in the engine cylinder. An abutment working in a slot on the outer case of the cylinder, projects into a chamber open to the action of steam or other fluid, which keeps the face of the abutment in contact with the eccentric piston, thus effectually dividing the steam from the exhaust. The supply of motive fluid is regulated by a disc valve working on the cylinder cover. (*Sealed December* 14, 1886).

GAS ENGINES.

13,163. L. A. Groth, London. (*G. Daimler, Cannstatt, Germany.*) **Improvements in Gas and Oil Motive Power Engines.** [8*d.* 8 *Figs.*] October 31, 1885.—The compression and combustion chamber A is connected with the working cylinder B, but is insulated from it as much as possible. A pipe *e* at the side of the chamber A carries the inlet valve *f*, the outlet valve *g*, and the igniting cap *h*. For moving the valves a disc J is keyed on the crankshaft. On the inner side of the disc is formed a curved groove *k* which passes twice round the crankshaft and returns into itself. A sliding piece *l* engages in the grove *k*, and is caused by the revolution of the disc J to transmit the motions corresponding to the rising and falling of the groove *k* to a rod *m*, which effects one opening and closing of the inlet and outlet valves for every two revolutions of the crankshaft



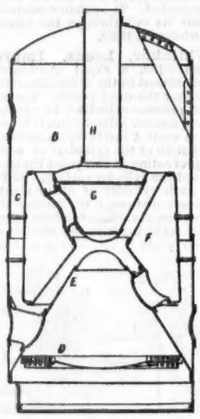
The firing cap *h* being heated by a gas flame, the flywheel is turned by hand and a mixture of air and gas or oil vapour is drawn into the cylinder. The mixture is then compressed in the chamber A and is ignited by the igniting cap *h*. At the next revolution the piston is urged forward by the action of the expanded gases. When the normal speed is reached, ignition takes place at the dead point. The compression and combustion chamber A becomes after a short time so hot that the ignition takes place in it, and the heating flame at the firing cap can then be dispensed with. The rim of the flywheel is furnished with wings *z* and is surrounded with a casing *d* which serves as a conduit for the current of air generated by the flywheel and the wings on its rim; this current of air is conducted round the working cylinder for the purpose of cooling the same. (*Sealed December* 7, 1886).

15,525. A. Ashby, London. Improvements in Gas Engines. [6*d.* 1 *Fig.*] December 17, 1885.—Inventor claims

the improved means for effecting the explosion of the gases in gas engines consisting of a tube of reduced diameter attached to a hollow boss formed on the cylinder cover at the exploding end; the ignition being caused by the heated products of combustion left over from the previous ignition in the tube and projecting hollow boss. (*Sealed December* 21, 1886).

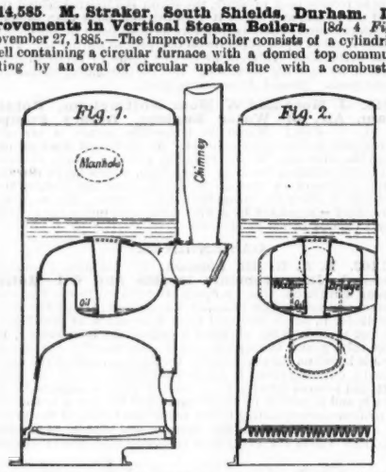
BOILERS.

13,090. W. Clarke, A. H. Chapman, C. A. Parsons, and J. B. Furneaux, Gateshead-on-Tyne, Durham. Improvements in Steam Generators. [6*d.* 1 *Fig.*] October 30, 1885.—The firebox E is of approximately conical shape, the upper part being surrounded by an annular water space that communicates with an outer annular water space terminating at its upper part in a water and steam space B similar to that of an ordinary vertical boiler. Above the firebox is the smokebox G,



also of approximately conical shape, but inverted, and surrounded by an annular water space united at its lower part with the upper part of the first-mentioned annular water space. The products of combustion pass from the firebox E into an annular flue F wherein they are divided, and whence they pass into the smokebox G, and thence away by the uptake H. C is the outer water casing, and D the firegrate. (*Sealed November* 2, 1886).

14,585. M. Straker, South Shields, Durham. Improvements in Vertical Steam Boilers. [8*d.* 4 *Figs.*] November 27, 1885.—The improved boiler consists of a cylindrical shell containing a circular furnace with a domed top communicating by an oval or circular uptake flue with a combustion



chamber forming an oblate sphere—having in it a water bridge, and with a water tube passing through it—opening through the flue F into a smokebox. The lower part of the combustion chamber contains a quantity of oil for the purpose of increasing the combustion and of consuming smoke. (*Sealed November* 26, 1886).

14,733. L. Berry, Rotherham, Yorks. Facilitating Water Circulation in Steam Boilers and the Consumption of Smoke in the Furnaces. [8*d.* 2 *Figs.*] December 1, 1885.—Instead of the usual cross-tubes in the boiler flue a number of hollow discs are employed having short tubular projections communicating with the interior of the discs and passing through packed glands in flue plates into the water space of the boiler. These short tubes form axes upon which the discs can be turned so that their flat sides may be presented at any desired angle to the current of hot gases passing through the flue. The bridge is hollow and communicates with the water space of the boiler by two or more pipes so as to cause a circulation of the water. An air receiver having a mouth or apertures is fixed at the back of the bridge, and communicates with the atmosphere by one or more tubes carried through the flue and opening into a valve box. (*Sealed November* 26, 1886).

15,795. J. Howden, Glasgow. Improvements in Steam Boilers. [11*d.* 14 *Figs.*] December 23, 1885.—The improvements relate more particularly to the construction and arrangement of the flues of internally fired boilers. (*Sealed December* 28, 1886).

130. G. H. Corliss, Providence, Rhode Island, U.S.A. Steam Boilers. [6*d.* 2 *Figs.*] January 5, 1886.—Inventor claims in a steam boiler having an internal furnace, a series of circulation tubes extending up and down between the furnace and the shell, open at each end and cut away to form lips. The tubes are secured to the boiler shell by fastenings which pass through the lips. (*Sealed December* 21, 1886).

12,262. E. S. T. Kennedy, New York, U.S.A. Flame Deflectors for Upright Boilers. [8*d.* 13 *Figs.*] September 28, 1886.—This invention relates to boilers consisting of an upright cylinder and tubes radiating from the same. The exposed ends of the radiating water tubes are protected from excessive heat, and the direction of the current of the hot gases with the combustion chamber is controlled, by means of a segmental or annular deflector resting on or suspended from certain of the boiler tubes or rivetted to the boiler jacket. (*Sealed January* 4, 1887).

BOILER FURNACES.

13,926. C. Hill, London. Improvements in Furnaces for Steam Boilers and other Purposes. [6*d.* 3 *Figs.*] November 14, 1885.—Steam pipes provided with apertures in their sides, are arranged below the grate of the furnace. The steam issuing in horizontal jets rises up to the grate, and tends to keep the bars cool, and prevent the formation of clinkers. It also assists the combustion of the fuel. (*Sealed November* 19, 1886).

15,470. C. Blagburn, London. Apparatus for Burning Liquid Fuel in Furnaces, Specially Applicable to the Furnaces of Marine Boilers. [8*d.* 2 *Figs.*] December 16, 1885.—An injector or spray producer placed at the back end of the furnace discharges a jet of liquid fuel or flame through a hollow cylinder or cone of fireclay towards the front end of the furnace. (*Sealed December* 21, 1886).

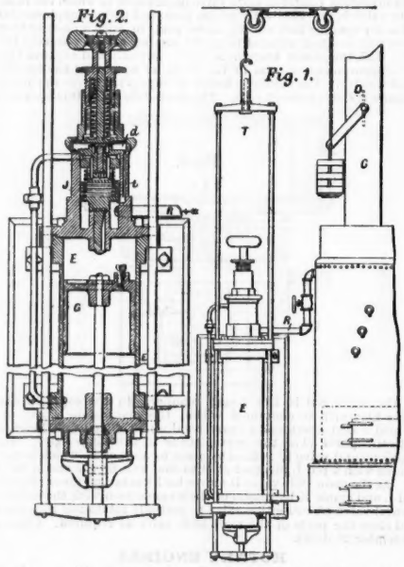
183. F. White, Walsall, Staffs. Improvements in Means Employed for Consuming Smoke Passing from the Grates of Furnaces, and Preventing the Emission of Smoke. [8*d.* 4 *Figs.*] January 5, 1886.—The improvements mentioned in the title are effected by dividing up into small separate streams the products of combustion passing from the furnace grate, and mixing the same with corresponding streams of air. (*Sealed January* 11, 1887).

662. J. C. Brentnall, Heaton Norris, Lancaster. Improvements in Steam Generator and other Furnaces. [8*d.* 5 *Figs.*] January 16, 1886.—The gratebars are arranged in sets of two, three, or more bars, each set containing a leading bar advanced and withdrawn by a cam, the leading bar moving the other bars of the set forward on the advance stroke by means of "pushers," and leaving them to be retracted by their own cams on the return stroke. (*Accepted December* 17, 1886).

4483. T. Bell, Newcastle-on-Tyne. Firebars for Marine and Land Boilers. [6*d.* 6 *Figs.*] March 31, 1886.—The firebars are so constructed that, when laid together, they form a grate, the surface of which consists of series of diamond-shaped figures with series of zig-zag air spaces between. (*Sealed November* 26, 1886).

9309. D. Mellor, Lenton, Nottingham. Furnace Firebars. [8*d.* 5 *Figs.*] July 17, 1886.—The firebars are constructed in the form of a hollow rectangle in cross-section. The bottom edge of the bar near the door of the furnace is carried below the dead-plate to allow the cold air from the exterior of the furnace to enter the air passage by an enlarged orifice. The other end of the bar is carried completely through the bridge and discharges the air through the open bar at the back of the bridge. The air becomes sufficiently heated in its passage to consume the smoke at the rear of the furnace. The inner surface of the bar may be lined with steel cast in the bar or afterwards fitted in. (*Sealed December* 31, 1886).

10,283. P. M. Justice, London. (*N. Curtis, Boston, Mass., U.S.A.*) **Improvements Connected with Damper Regulators for Steam Boiler Furnaces.** [8*d.* 2 *Figs.*] August 11, 1886.—This invention relates to that class of damper regulators in which steam from the boiler whose fires it is desired to regulate, is employed for moving the damper in one direction, while a weight is employed for moving the damper in the other direction, no steam for the boiler being required except when it is desired to overcome the force of the weight. The object of this invention is to provide an exceedingly sensitive apparatus. The damper D is weighted so as to normally stand open. Its lever is



connected by a chain passing over pulleys with the piston G of the steam cylinder E. Steam is admitted to the cylinder through the port C, the piston valve J and the pipe R leading from the boiler. Normally the steam pressure above and below the piston valve J is equal. Above the piston valve is an exhaust port which is normally closed by a spring-weighted diaphragm valve *d*. When the steam pressure upon this diaphragm overcomes the force of the spring, the exhaust port is opened and the pressure above the piston valve J is relieved, thus causing the piston valve to open and admit steam to the piston G that is connected to the damper lever. (*Sealed November* 19, 1886).

10,334. T. Sellars, Nottingham. Method of Forming the Outlet Passages for Blast in Hollow Firebars which are Built up of Two or More Pieces. [8*d.* 4 *Figs.*] August 12, 1886.—This invention has for its object the making of built-up hollow firebars with outlets for the distribution of the blast to the superposed fuel, in such a manner that when the several component parts of the bar are put together the bar is complete in itself and does not depend on the adjoining bar for the proper formation of the outlets. To effect this the projections required to form the blast outlets are placed on the inner side of the hollow bar. The blast is caused to enter the furnace at a sharp angle upwards direct from the bar without being directed through nozzles formed in the space between the bars. (*Sealed January* 14, 1887).

10,961. W. C. Thayer, Chicago, Ill., U.S.A. Improvements in Furnaces for Steam Boilers and other Purposes. [8*d.* 15 *Figs.*] August 27, 1886.—The improvements have the object of producing complete combustion by passing heated air into hollow spaces formed in the body of the fuel, and injecting steam and air in a broad thin sheet on to the surface of the fuel, whereby the gases are intimately united, and the formation of smoke is prevented. The furnace grate is composed of a series of rocking bars provided with arched air distributors, and connected with an undulating bar by pivotal connections whereby the bars may be rocked, and the air distributors moved to alternately increase and lessen the space between them. (*Sealed December* 3, 1886).

14,690. A. M. Clark, London. (*C. S. Wilcox, Chicago, Ill., U.S.A.*) **Means of Effecting the Consumption of Smoke in Furnaces.** [6*d.* 3 *Figs.*] November 12, 1886.—The smoke passes along the under side of the boiler to the back end, returns through the boiler flues to the smokebox at the front end and is taken from the circulation flue through a pipe by an exhaust fan, then forced through a pipe into the hollow bridge or receiving box, and thence through apertures into and through the hollow perforated grate bars, from the perforations of which it issues into the incandescent fuel resting on the bars, whereby the smoke is consumed and utilised as fuel. (*Accepted December* 14, 1886).

ENGINE AND BOILER FITTINGS.

15,498. H. Field, St. Johns, Kent. Packing for Steam and other Engines. [8*d.* 3 *Figs*] December 17, 1885.—The invention consists essentially in the combination of asbestos or other suitable cloth or woven material with strips of india-rubber or like elastic substance. (*Sealed December* 10, 1886).

15,500. J. J. Galloway, Govan, Lanark, N.B. Packing for the Stuffing-Boxes of Steam Engine Cylinders and other Apparatus. [8*d.* 4 *Figs.*] December 17, 1885.—The improved packing consists of strands of asbestos yarn saturated with tallow and wrapped round with fine brass or copper wire. (*Sealed December* 21, 1886).

2256. J. Cameron, Steamship "Fimbar," Cork, Ireland. Improvements in Water Gauges for Marine Boilers. [8*d.* 3 *Figs.*] February 16, 1886.—The improvements consist in providing the gauge glass brackets with valves which are loosely linked to spindles by means of which they can be forced to or withdrawn from their seats, while at the same time they are free to move and come to their seats when their equilibrium is destroyed and the pressure is greater at the back than at the front, through fracture of the gauge glass while under pressure. (*Accepted December* 17, 1886).

6227. W. Dixon and S. Thompson, Owlerton, Yorks. Improvements in Pistons for Steam Engines. [8*d.* 3 *Figs.*] May 8, 1886.—The piston body is made with a suitable number of radial holes round its external surface in which are placed a corresponding number of spiral springs. Within each spring is fitted a metal stud having a tapered head to open out or expand the outer ring of the piston. (*Sealed December* 14, 1886).

HEATING FEED WATER, &c.

13,987. C. V. Boys and H. H. Cunynghame, London. An Improved Device for Cleansing Steam. [8*d.* 4 *Figs.*] November 16, 1885.—Water and other impurities are separated from steam by centrifugal action caused by a vortex of steam in a circular chamber. The cleansed steam is drawn off by a pipe from the centre of the vortex, and at the point of least velocity. (*Sealed November* 23, 1886).

15,297. A. Lencauchez, Paris. Apparatus for Heating Feed Water and Supplying it to Steam Generators, and Treating and Utilising the Exhaust Steam of Steam Engines for the said Purpose. [11*d.* 14 *Figs.*] December 12, 1885.—The exhaust steam from an engine is purified in a grease separator and is then brought, together with the steam from the cylinder jackets, into direct contact with the feed water, whereby the steam is condensed, and the water takes up the heat of evaporation and the heat due to the difference between the temperature of the steam and that of the feed water. (*Accepted December* 17, 1886).

9276. E. Bohlig and G. O. Heyne, Leipzig, Germany. Process of Separating Waste Lye for Manufacturing Carbon-Magnesia as Material for Cleansing Feed Water for Boilers. [4*d.*] July 16, 1886.—According to this invention carbon-magnesia is obtained as main product for purifying feed water for boilers by mixing and heating chlorate of magnesia lye with sawdust. Hydrochloric acid is obtained as a subsidiary product. (*Sealed January* 4, 1887).

10,819. A. J. Boult, London. (*T. Clifford, Mount Savage, Maryland, U.S.A.*) **Steam Boilers and Water Heaters therefor.** [6*d.* 2 *Figs.*] August 24, 1886.—This invention relates chiefly to the combination with the smokebox of a boiler, of an encircling water jacket provided with inwardly-extending pockets connected with longitudinal water tubes extending through the smoke space. (*Accepted November* 16, 1886).

14,646. W. E. Gedge, London. (*J. E. Carroll, San Francisco, U.S.A.*) **Apparatus for Heating and Purifying Feed Water before its Introduction into the Boiler.** [8*d.* 4 *Figs.*] November 12, 1886.—The improved apparatus consists of a tubular chamber extending through one end of the boiler to nearly its whole length and having within it a horizontal diaphragm which divides it into two parts. Water is first introduced by pipes into the lower part, passing along the tube and through vertical holes at the inner end of the diaphragm into the upper part of the chamber, where it returns above the diaphragm and is finally discharged into the boiler through openings in the upper part of the tubular chamber near the receiving end. (*Accepted December* 14, 1886).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford street, Strand.

SAFETY LAMPS.—At the forthcoming Exhibition at Newcastle-on-Tyne a special feature is to be made of miners' safety lamps. Entries of these can be made up to February 19th, and the lamps must be delivered before April 14th. A charge of six shillings per lamp will be made, and this will be, we believe, the only expense incurred by exhibitors.

TELEPHONY IN SCOTLAND.

IN no part of the United Kingdom has telephony reached a greater degree of development than in Scotland. While in England very many important towns are yet without the benefits of an exchange system, there is no town in Scotland of more than 16,000 inhabitants that does not either already possess an exchange, or for which preparations have not already been made for the creation of one in the near future. In some of the small towns the development achieved will compare favourably with that of most of the American cities, as the following Table will show :

Town.	Number of Inhabitants.	Number of Telephones.	Persons per Telephone.
Glasgow	488,000	1323	368
Edinburgh	229,000	421	543
Dundee	140,000	764	183
Aberdeen	105,000	493	213
Perth	29,000	130	223
Inverness	17,500	78	224

Exchanges are likewise in operation at Greenock, Paisley, Dumbarton, Hamilton, Coatbridge, Kirkcaldy, Forfar, Arbroath, Ayr, Troon, Ardrossan, Kilmarnock, while others are being constructed, or are about to be undertaken in Falkirk, Stirling, Alloa, Burntisland, Cupar-Fife, Galashiels, and Selkirk.

A considerable number of these towns are already in telephonic communication with each other, and extensions are in progress with the object of connecting other towns, so that it is probable that within a couple of years Aberdeen, if not even Inverness, will be on speaking terms with Dundee, Edinburgh, Glasgow, and the Ayrshire and Border towns. The communications passing between the towns already connected are extremely numerous during the business hours of the day, and the trunk lines are in themselves distinctly remunerative. According to the paper which was read by Mr. W. H. Preece on "Long Distance Telephony," before the Society of Telegraph Engineers and Electricians last session, it is found in the United States that inter-town lines do not pay, and are only useful as serving to attract additional subscribers to the terminal local exchanges. In Scotland, however, the reverse is the case, as the additional subscriptions exacted for the use of the inter-town lines, yield a fair return on the capital invested.

The Scottish telephonic system is wholly in the hands of the National Telephone Company (Limited), which also possesses an extensive system in England and in Ulster. On April 30, 1886, the company had thirty-five exchanges in working order, with 6696 subscribers, served by 7161 miles of wire. When it is borne in mind that the company was only incorporated in 1881, the progress made is by no means insignificant.

When it was determined to hold an International Exhibition in Edinburgh in the past year, various local exhibitors made application to the company for communication to be effected between their stands and their offices or places of business through the Edinburgh Exchange; and it soon became evident that the establishment of a branch switch-room in the Exhibition would become a necessity. The company thereupon decided to become exhibitors on their own account, and to show a switch-room in actual operation, together with samples of the telephonic apparatus used in the working of their extensive system. It may be affirmed that the result was, perhaps, the finest display of telephonic instruments and material ever seen in this country—a display, which gained additional interest from the fact that the apparatus used by the National Telephone Company in the construction and working of their lines and exchanges differs in many particulars from that of the other telephone companies, and that a large proportion of the exhibits was manufactured in the workshops recently established by the company in Edinburgh, which are the first of their kind in Scotland. It may be remarked that the first

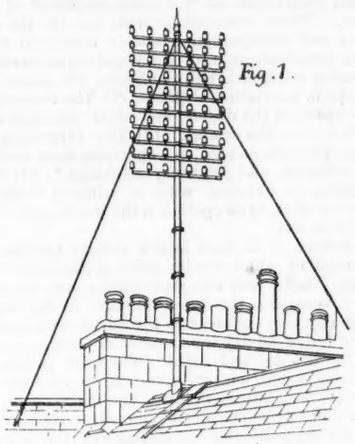


Fig. 1.

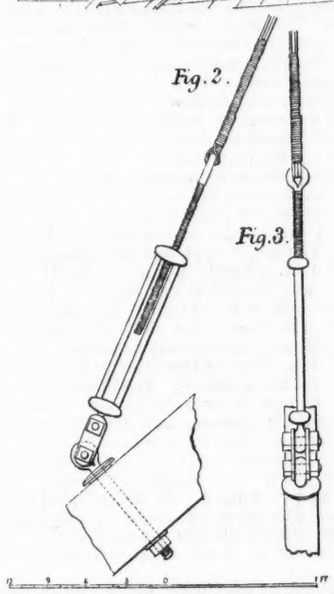


Fig. 2.

Fig. 3.

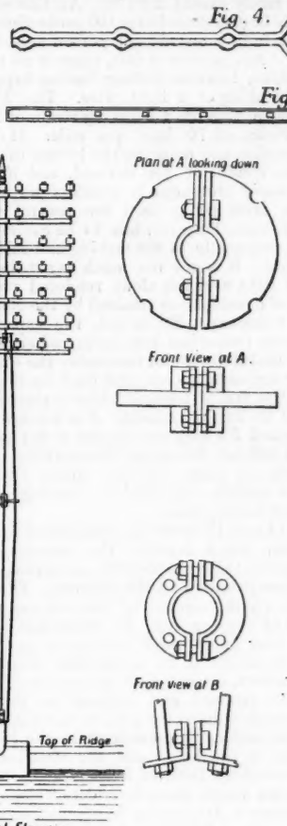
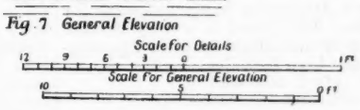


Fig. 7 General Elevation



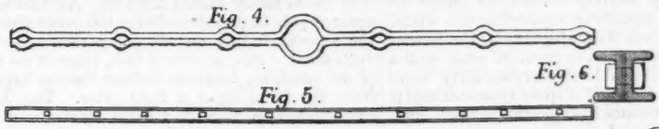


Fig. 4.

Fig. 5.

Fig. 6.

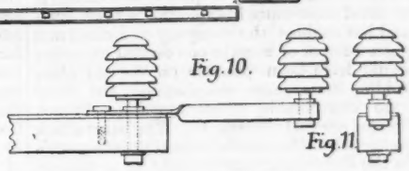


Fig. 10.

Fig. 11.

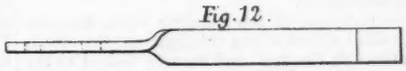


Fig. 12.

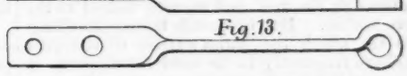


Fig. 13.

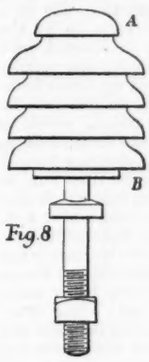


Fig. 8

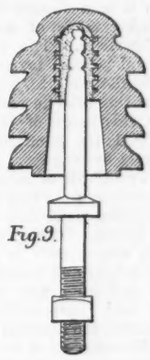


Fig. 9.

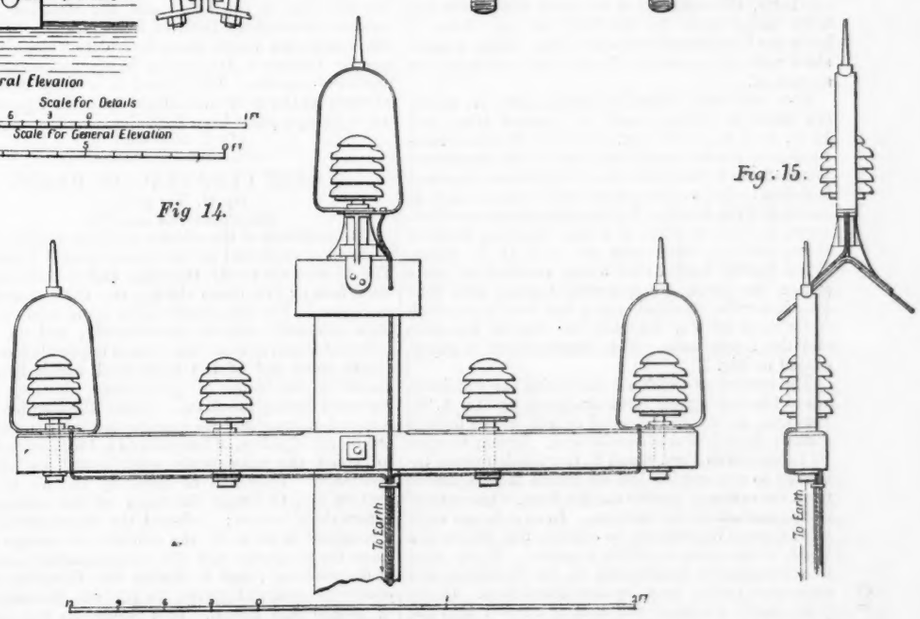


Fig. 14.

Fig. 15.

noticeable difference in the National Telephone Company's apparatus lies in the construction of the standards, or house-top supports for overhead wires. The form of standard ordinarily used by the Post Office and the United Telephone Company—in fact, by all the companies except the National—consists of a malleable iron tube held upright by stays or guys, and to which the wires are affixed, one below the other, at a distance of about 9 in. apart. A tube, 10 ft. in length, if loaded to within 2 ft. of its base, will, on this plan, carry only ten wires. The National Company employ cross-arms made of channel iron, each capable of supporting six wires. If these arms are fixed 9 in. apart, as in the former case, six wires are obtained in room of one, and a 10-ft. tube becomes capable of carrying sixty wires in lieu of ten. The economy of space thus obtained is of the greatest importance in exploiting a town overhead, and has enabled the company to concentrate a far larger number of wires in one central exchange than would have been possible on the old plan, thus avoiding the expense, complication, and delay which are unavoidable when numerous branch switch-rooms are had recourse to. The wires which were connected to the switch-table at the company's stand in the Exhibition were brought to a support of this description.

If the structure of the building which supports the standard admits of the arrangement, the butt is taken through the roof and securely bolted to the timbers within. But in Scotch towns, dwelling-houses (in which the attics extend to the very slates) have frequently to be used for supports, in which cases it is necessary to rest the tube in a cast-iron socket made of saddle form to fit the shape of the ridge. The ridge is covered with sheet lead and several layers of felt; the saddle, which weighs about 56 lb., is placed upon this foundation, and the tube is securely wedged into its socket. In this mode of construction, which is shown in Fig. 1, the standard is, of course, held up almost entirely by its guys. The tubes are formed of the best wrought-iron steam pipes, from 3 in. to 4½ in. in diameter, according to the load which may have to be carried; and they vary from about 6 ft. to 41 ft. in length. The guys are fastened to eye-bolts, which, whenever it is practicable, are taken through the rafters and secured beneath by means of washers and nuts, the bolt-holes being made water-tight with india-rubber and white lead. Straining screws are inserted between the guys and eye-bolts, the connection between the screws and bolts being made by shackles, as every form of hook has been found untrustworthy. Figs. 2 and 3 show the arrangement of guys and eye-bolts just spoken of.

The cross-arms, which generally carry six wires, are made in halves, each of channel iron, and 1¼ in. by ⅜ in., 5 ft. long, forged to fit the circumference of the tube and the stalks of the insulators. When fitted to the tube, the two parts are fastened together by bolts and nuts so as to form one arm, as shown in Figs. 4 and 5. The inner insulators are 15 in. apart, in order to allow of a man climbing between them, and the outer ones are only 11 in. apart. When heavily loaded with wires, meeting at acute angles, the tubes are generally trussed with four ⅛ in. iron rods, strained over a cast-iron disc, which is fastened midway between the butt of the tube and the lowest arm. This arrangement is represented in Fig. 7.

The insulators which are used with the standards are of the corrugated form designed by Mr. A. R. Bennett, to whom the novel details of the fittings already described are likewise due. As may be seen by reference to Figs. 8 and 9, the insulators are intended to prevent the leakage which is inseparable from the ordinary double shackle form, while retaining its mechanical advantages. In over-house work it is of great importance to confine the effects of a break to the span on which it occurs. Every span is consequently terminated at its insulator, and connected to the next by a soldered loop. In the "Bennett" insulator the bolt is carried into the head to above the level of the topmost groove, so that in the event of the porcelain breaking, the wire catches in the bolt, and is prevented from falling into the street. The corrugations and inner cup of the insulator provide a large amount of dry service, so that a wire fixed to these insulators, tests, in wet weather, about eight times better than one supported by double shackles.

At the Telephone Company's stall there were also exhibited samples of the silicium-bronze wire, employed by them for over-house work, together with the drums and other apparatus used in erecting it. The National Telephone Company can claim to be the pioneers in the use of light wire in this country, the first having been erected in Glasgow in February, 1882. The original light wire was made of phosphor-bronze of No. 20 B.W.G., but for the last four years this has been superseded by silicium-bronze wire of No. 18 B.W.G. It weighs only 38 lb. to the mile, and as it is seldom erected in longer spans than 100 yards, it follows that the greatest weight which could fall into the street as a result of the breaking of a wire could rarely exceed 2.16 lb. As this weight, again, would be distributed over 100 yards of ground, the amount falling on any one person must be infinitesimal. As a matter of fact, there is no record of an accident, however trifling, having happened from the breaking of a light wire. The No. 18 silicium-bronze wire has a breaking strain of 2 cwt. and a resistance of 70 ohms. per mile. It causes far less vibration and noise in the houses than any form of iron conductor yet devised, and if it be kept well above chimneys it exhibits no sign of decay even after being used for several years. Considerable care, however, has to be exercised in its erection, especially in the making and soldering of the joints. It is not too much to say that the adoption of light wire has alone rendered possible the degree of development attained by the National Telephone Company. By its aid, the capacity of the over-house routes has been increased sixfold.

Another useful device for increasing the capacity of existing supports shown and used by the company, was the arm extension which is represented in Figs. 10 to 13. It consists of a wrought-iron bracket adapted for easy attachment to the ends of oaken arms without disturbing the working of the wires already on them. By its means two-wire arms can be readily converted in four-wire arms, and four-wire into six-wire.

At Figs. 14 and 15 there is represented another improvement, which involves the attachment of lightning guards to telegraph poles, an arrangement which has been patented by Mr. Bennett. The insulators, fixed on the summit of the pole and at the extremities of the top arm, are surrounded by a galvanised iron hoop which carries an iron spike extending to about 6 in. above the insulators. Earth conductors, consisting of iron wires stranded together, are rivetted and soldered to the iron hoops, and stapled down the pole to its base, where a coil of good surface is embedded in the ground. The flat iron of the hoops and the stranded iron conductors seem to fulfil in a remarkable degree the conditions which were formulated some time ago by Professor Hughes as being necessary for lightning guards. This guard is a very decided advance on the method hitherto in use for protecting telegraph poles from lightning.

(To be continued.)

STREET CLEANING IN PARIS.

By H. Vivarez.

(Concluded from page 75.)

The mildness of the climate of Paris renders the removal of snow and ice more easy than in London. The winters are rarely rigorous, and it only snows some four or five times during the cold season of each year. The fall usually lasts some hours; the thaw generally follows immediately, and in the centre of Paris, at least, the ground is quickly cleared of the snow and of the black mud which is produced by the traffic of pedestrians, horses, and carriages during the thaw. Under the Empire the removal of snow and ice was effected in virtue of an ordinance of police, of December 14, 1851, according to which the inhabitants were bound to render assistance. They had to break up the ice in the gutters and to sweep the snow off the pavement before their houses; to shovel the snow into heaps if required to do so by the officials; to scrape and clean the footpaths and the corresponding portion of the roadway; and to scatter the footpaths and road with sand and gravel, to prevent the slipping of people and horses. This regulation was naturally observed in an indifferent fashion, and never worked well. It had further the inconvenience of pressing unequally on the inhabitants, for those living in narrow streets had far fewer square yards to clean than those dwelling in the boulevards and avenues. Besides, the heaping up of the snow did not occur just at the time when the city carts appeared to take it away. The increase in length of the streets and roads in turn rendered this method of removal inapplicable.

This state of things continued until after the war of 1870. At the time a regulation of M. Leon Say, Prefect of the Seine, was issued to settle the respective parts to be borne by the inhabitants and the city scavengers in the removal of ice and snow. According to that order the snow is heaped up by the inhabitants and the scavengers. It is then either thrown directly into the sewers or into the Seine, or into convenient places, or else it is removed by carts. The Compagnie des Omnibus is obliged, by its charter, to furnish fifty carts with two horses each; for the other vehicles contracts are made with various individuals at the commencement of the winter. These contracts provide for (1) the collection and transport to places of discharge fixed by the administration, of snow and ice gathered in the public ways, either to the Seine, the sewers, or to heaps in provisional depôts. (2) The removal of the heaps from the depôts, and their discharge into the Seine or the sewers. (3) The furnishing of horses, when demanded, for operating snow collecting, scraping, and brushing machines.* (4) The furnishing of navvies, with or without foremen, when required, to co-operate in the working of clearing the streets.

This work is divided into a certain number of lots, each of which has its point of discharge, and definite limits, and every contractor has to enter into a bond for the due fulfilment of his work. Every day the engineer of the section requisitions for the following day the number of carts and men, both for the day and night. The work is paid by the cubic metre, either according to an estimate formed of the heaps, or from the capacity of the carts. The price per metre is fixed on the spot for each lot according to the distance of the point of discharge. This price, and the other complementary prices, form an account for each of the lots.

When the thaw takes place the hydrants are opened, and brushes, both hand and machine, sweep the snow into the sewers. It is, therefore, an advantage to hasten the melting of the snow. This has been attempted by means of jets of steam, but the action has not been found to be complete, for it ceases when the cavity attains a certain size. On the other hand salting the streets to produce melting has not ceased to increase since it was first tried on a large scale in the severe winter of 1879-80. The initiation of this interesting method was due to M. d'Ussel, Ingénieur des Ponts et Chaussées, who directed at that time the works in the seventeenth and eighteenth arrondissements. It will be remembered that the winter was exceptionally cold, and that contrary to custom 10 in. to 14 in. of snow fell after December, while the thaw did not occur for a month. Traffic was impeded, accidents to persons or vehicles were extremely frequent, and the tramway and carriage companies kept up only an irregular service. The soil was frozen, and became very hard; and the applications of gravel were insufficient, owing to the difficulty of procuring it. M. d'Ussel then struck the idea to apply salt to the roads of his arrondissement. He treated 210,000 square yards of roadway with 55,000 lb. of salt, and obtained excellent results.

Sea salt mixed with snow forms a refrigerating mixture of which the temperature descends to −21 deg. Cent., the proportion being one part of salt to two parts of snow. This mixture has the property of remaining liquid. If the salt be scattered over the surface of the frozen ground, it produces an artificial thaw, and forms a black mud which it is easy to sweep off and throw down the sewers. If there is not too much snow it is advisable not to brush it off immediately in order to guard against an ultimate freezing. The salt is spread on the road by a man who pushes before him a wheel-barrow filled with the material, which he scatters on the ground. It is immediately trodden in, and incorporated with the snow, without much care on the part of the man to insure an equal distribution. In general, when the snow, consolidated with ice, has a thickness of 1½ in. to 2 in., it is necessary to reckon on an average of 200 grammes of salt (.44 lb.) to the square metre (10.7 square feet). If the thickness amount to 6 in. or 8 in. the application is made twice, the surface snow being removed between the two. The tramway companies also salt the streets in the parts traversed by their lines.

* The employment of snow sweeping machines is not extended in Paris. The traffic being very active it is trodden down, and quickly reduced to a thin hard coating. Two forms of snow sweepers have been constructed, one operated by hand, and the other drawn by horses. Neither of these has been much employed.

TABLE I.—COMPARATIVE STATEMENT OF THE COST OF CLEARING THE ROADS OF THE FIRST DIVISION.

Date of Snowstorm.	Time.	Temperature during Fall.	Density of Fallen Snow.	Thickness of the Fallen Snow.	Weight of Snow per Square Yard.	Quantity of Salt Employed. For the Entire Division.	Per Square Yard.	Per Square Yard and Inch of Thickness.	Per Pound of Snow	Total Expenses. For Entire Division.	Per Square Yard of Total Area.	Per Square Yard and Inch of Thickness.	Per Pound of Snow.	Remarks.
1885.		deg. C.		in.	lb.	lb.	lb.	lb.	grains.	£	d.	d.	d.	area sq. yards.
January 12 ..	6 to 8 p.m.	0 to +1	.091	1	4.2									
,, 13 ..	9.30 to 10 a.m.	0	.075	.4	1.35									
	3 to 3.30 p.m.	+1	.094	.6	2.6									
	7.30 to 9 p.m.	+1	.098	.020	.9									
,, 14 ..	3.30 to 12 p.m.	−1	.080	1.40	.51									
				3.6	9.56	1,203,710	.297	.082	259 or 3.5 p.c.	4720	.29	.08	.03	4,050,000
December 8 ..	7 a.m. to 2 p.m.	+1	.133	.44	27.2									
,, 10 ..	2 to 6 a.m.	−1	.120	.80	4.43									
				.52	31.63	945,333	.232	.044	51.8 or .7 p.c.	4280	.26	.05	.008	4,100,000
1886.														
January 8 ..	noon to 2.30, 4 to 4.30 p.m.	−1	.082	.140	5.3									
,, 11 ..	noon to 11 p.m.	0 to −1	0.156	.040	2.86									
,, 13 ..	midnight to 6 a.m.	1 to +1	.206	.04	3.8									
				.22	11.96	891,762	.236	.107	137.9 or 1.97 p.c.	2520	.15	.060	.0126	4,100,000
January 22 ..	1 to 8 a.m.	−2	.072	.30	9.8									
	12 to 4.30 p.m.	−1	.066	.04	1.2									
,, 24 ..	5 to 6 a.m.	−2 to −3	.081	.02	.73									
				.36	11.73	687,840	.168	.0465	98 or 1.4 p.c.	4560	.28	.077	.023	4,100,000

TABLE II.—*Money Expended on the Occasions of the Snow Storms of January 8 to 13, and of January 22 to 24, 1886.*

1. January 8 to 13. First Division.

Supplying Sand.	Supplying Salt.	Horse Hire. For Mechanical Sweeper.	Horse Hire. For Transport of Snow and Salt.	Overtime of Regular Workmen.	Hired Men.	Miscellaneous Expenses.	Total.
£	£	£	£	£	£	£	£
160.84	611.76	185.84	43.52	1064.24	457.48	13.64	2427.36

2. January 22 to 24.

£	£	£	£	£	£	£	£
350.60	742.60	369.36	58.32	1255.56	1595.20	149.36	4451.12

SECOND DIVISION.—*The Tables which follow give the detail of cost of the removal of snow in the second division during the same period.*

TABLE III.—COMPARATIVE STATEMENT OF COST OF CLEARING ROADS OF SECOND DIVISION.

Dates of Snow-storms.	Time.	Temperature during the Fall.	Thickness of the Fallen Snow.	Density of the Newly Fallen Snow.	Weight of Snow per Square Yard.	Quantity of Salt Employed. For the Entire Division.	Per Square Yard.	Per Square Yard of 1 in. Thickness.	Per Pound of Snow.	Total Expenses. For the Entire Division.	Per Square Yard.	Per Square Yard of 1 in. Thickness.	Per Pound of Snow.	Remarks.
1885.		deg.	in.		lb.	lb.	lb.	lb.	lb.	£	d.	d.	d.	area sq. yards.
Jan. 12 ..	6 p.m.	0												
,, 13 ..	9 to 11 a.m.	−1.5												
	3 to 4 p.m.													
	7 to 9 p.m.	−3												
Dec. 8 ..	morning	0	4.0	0.120	22.0	1 322,760	0.295	.072	..	4960	.278	.0095	..	4,600,000
,, 10 ..	dawn	−3	0.4	0.113	2.1									
			4.4		24.1	1,494,720	.32	.071	.0293	4800	.257	.058	.0105	4,630,000
1886.														
Jan. 8 ..	afternoon	+.7 to −4	1.4	0.068	4.42									
,, 11 ..	,,	−1 to −6.4	.24	0.150	1.65									
,, 13 ..	night	+6 to −3	.4	0.190	3.52									
			2 04		9.59	1,426,380	.31	.150	.0707	3828	.202	.1	.021	4,630,000
	dawn	..	3.2	0.065	9.7									
Jan. 22 ..	afternoon	−3 to −5	.40	0.065	1.2									
,, 24 ..	5 to 6 a.m.	−7.2 to +4.9	.12	0.073	.41									
			3.72		11.31	1,247,800	.27	.071	.0524	3360	.178	.048	.016	4,630,000

What is the cost of salting? The principal element is evidently the price of the salt itself. This material is found in commerce in several forms. At the time the experiment commenced the only form available was the refined salt, worth at Paris 22 francs per 100 kilos. (about 1d. a pound), upon which there are 6 francs of *octroi* dues, and 10 francs of State dues. The material itself is only worth 6 francs; powdered salt is worth 3 francs. The cost of the operation is as follows: At 200 grammes (.44 lb.) per square metre the surface is guaranteed against freezing during four or five days. That quantity corresponds to a cost of .044 franc for material and .001 franc for labour, that is .45d. per square metre. Under like conditions sanding requires a layer of gravel 1 centimetre thick (.4 in.), and this at 4.5 francs the cubic metre, would cost .45d. for material. The covering would require to be renewed about eight times to maintain the road in good condition for four or five days. The labour costs .8d., and consequently the entire operation amounts to .93d., or .08d. more than the salting. Later we shall make a more exact comparison between sanding and salting.

An attempt was made to employ chloride of calcium, which is not subject to duty, and is, further, cheaper than sea salt. But it had to be abandoned because it had an acid reaction, and stained the garments of pedestrians.

Having thus dealt generally with the subject, we will now give some information relative to the removal of snow from the ground of Paris during the winter of 1885-86. This we are enabled to do by the aid of official documents which the Director of Works of Paris has kindly placed at our disposal. The last winter was remarkable, if not for its low temperature, at least for the persistence of the cold and the frequency of the snow. From December 8, 1885, to January 25, 1886, snow fell seven times to various extents; on December 8, January 11, 22, and 24, the depth of the covering was 4 in. Thanks to the salting the snow was always removed the same evening, and the traffic was never interrupted. This affords a striking contrast to the experience in London, where the snow lay for days and weeks, and perfectly paralysed the vestries. The Minister of Finance reduced the tax on salt to such an extent that it could be delivered at the depôt at 28s. per ton.

Contrary to the experience at other European capitals, such as Vienna and Berlin, a fall of snow is generally followed at Paris by a barometric depression, and by winds from the south and south-west. These bring a warmer temperature, which reduces considerably the transport of the snow, and permits of water being extensively used to carry it off through the sewers. Mechanical sweepers can also be employed to serve the same purpose.

In the first division the quantity of salt consumed from the 8th to the 13th of January was 440.5 tons, and from the 22nd to the 24th of January 312 tons, or 752.5 tons in all. This quantity spread over the first division, which has an area of 3,438,100 square metres, corresponds to 219 grammes per square metre. In relation to the quantity of snow the salt amounted to 1.7 per cent. of the snow by weight. In December the consumption was 125 grammes per square metre, and 8 grammes per kilogramme of snow (.8 per cent.) There were two falls of snow in December and six in January. The annexed Tables I. and II. show the elements of expense relative to the removal of snow in the first division in 1885-86.

It is thus demonstrated that the expense of the removal of snow for the entire area of Paris during the month of January, 1886, amounted to 14,258*l*. The quantity of salt employed was 4,433,000 lb.

In order to appreciate the value of these statistical results it is necessary to ask what is the economy resulting from the use of salt? Let us, for sake of example, consider the two falls of December 8 and January 22 in the second division, and examine what would have been the expense of the removal of the snow if salt had not been employed. After the 8th of December the frost lasted until the 13th; in the afternoon the thaw commenced. In the second case the frost held until the afternoon of January 25. Under these conditions the snow must have been carted away, and have been tipped either into the Seine or into the sewers, or into heaps. The cost of these operations can be easily estimated. On December 8 the snow attained a thickness of 4.4 in. It would have been necessary to have cleared one-third of the roads and pavements;

TABLE IV.—*Money Expended on the Occasion of the Snow Storms of January 8 to 13, and of January 22 to 25, 1886.*

1. January 8 to 13. Second Division.

Supplying Sand.	Supplying Salt.	Horse Hire. For Mechanical Sweeper.	Horse Hire. For Transport of Snow.	Removal by Contract.	Overtime of Regular Workmen.	Hired Men.	Miscellaneous Expenses.	Total
£	£	£	£	£	£	£	£	£
406.92	806.88	212.48	8.48	78.28	1455.88	704.8	92.12	3819.84

2. January 22 to 24.

£	£	£	£	£	£	£	£	£
304.60	698.4	241.44	172.20	22.28	926.96	860.44	133.56	2559.88

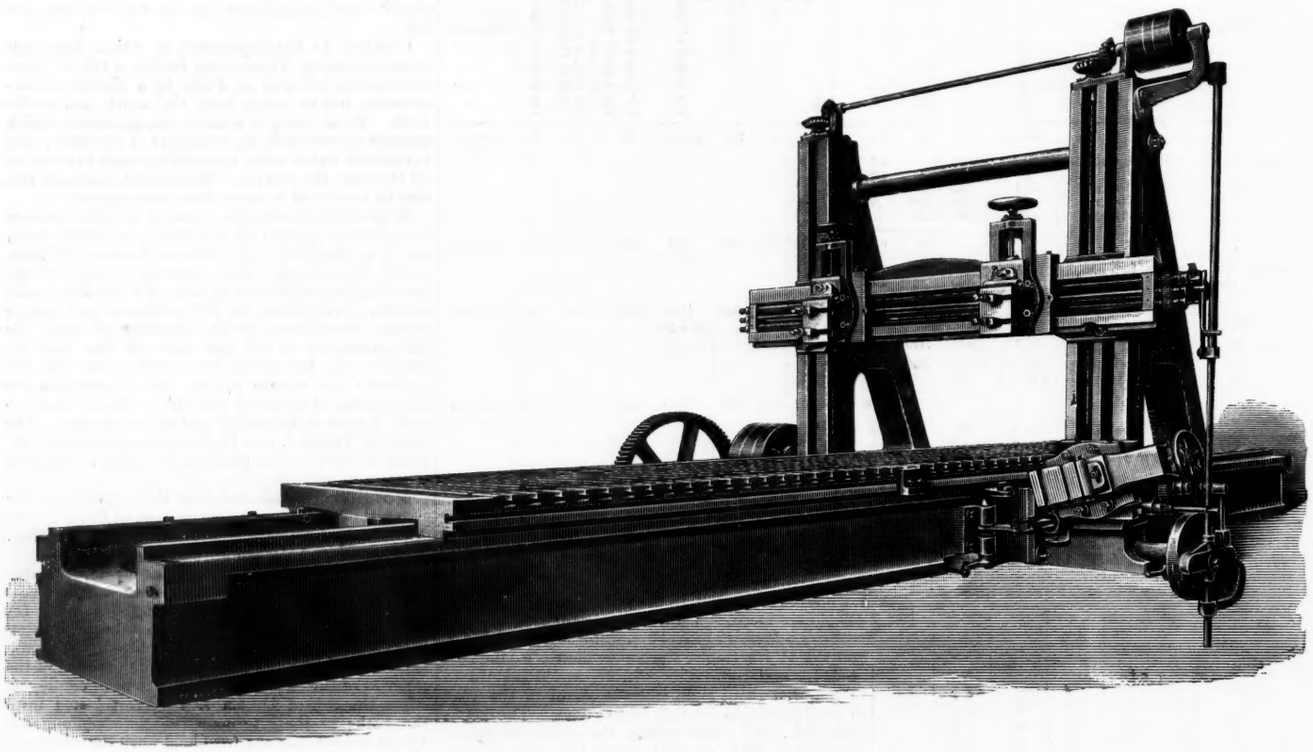
that is, for the second division 2,636,000 square metres, producing 289,960 cubic metres of snow. On January 22 the thickness of the snow was 3.2 in. corresponding to a volume of 210,880 cubic metres. The two together amount to 500,000 cubic metres. The average price of transport would have been about 1s. 3d. per cubic metre, or 30,000*l*. in all. To this must be added the labour in heaping the snow, in scraping the street surface, and in sanding the roadway. Taking these at the same price as has been paid when salt was used, we arrive at the amount of 32,200*l*. The actual expense was 8160*l*., showing an economy of 25,040*l*. For the entire area of Paris during the month of January the expense would have been, without salt, more than 60,000*l*., while with salt, it was 14,260*l*.

BELGIAN COAL EXPORTS.—The exports of coal from Belgium in the first ten months of last year amounted to 3,445,910 tons, as compared with 3,525,636 tons in the corresponding period of 1885. In these totals the exports to France figured for 3,135,303 tons and 3,258,979 tons respectively.

PLANING MACHINE.

CONSTRUCTED BY MESSRS. GEORGE BOOTH AND CO., ENGINEERS, HALIFAX.

(*For Description, see opposite Page.*)



LITERATURE.

Die graphische Theorie der Turbinen und Kreiselpumpen. By Gustav Herrmann, Professor at the Royal Technical University at Aachen. Berlin: Leonhard Simeon.

In this work the author applies the graphical method to the solution of all the ordinary problems connected with turbines and centrifugal pumps, in a way which we believe is for the most part novel. For determining the angles of entrance and exit of the vanes of turbines, the graphical method has of course been previously used, but has not been applied, as in the work before us, to ascertain the absolute velocity of flow and losses from friction, sudden changes of velocity, and other causes.

The construction of the diagrams is very simple, a few easy calculations are of course necessary as preliminaries to the graphical process, but no trigonometry even is essential—although used in the introductory paragraphs to explain the theory—and the work is thus adapted for the use of students with a very elementary knowledge of mathematics and geometry.

The first few paragraphs are devoted to the general principles applicable to turbines and centrifugal pumps (the impact and reaction of water on surfaces of various forms, &c.); each of the standard types of turbine is then dealt with in succession.

Numerical examples are worked out, illustrated by diagrams showing the practical application of the author's method. The concluding paragraph is on centrifugal pumps. The work is illustrated by numerous diagrams in the text and seven well-executed plates. There is nothing novel in the principles forming the basis of the author's system; he makes the usual assumptions, that the water enters the wheel without impact and leaves it radially in radial-flow turbines and axially in parallel-flow turbines.

Considerable attention is given to the losses due to the thickness of the vanes, which the author believes to be more considerable than is generally supposed. Where in parallel-flow turbines the difference between the inner and outer diameter is relatively great, a construction of the vanes is shown by means of which the water may be made to enter and leave the wheel under the assumed conditions with equal accuracy at all diameters.

With regard to turbines with free deviation, or, as the author calls them, action turbines, as distinguished from so-called reaction turbines, it is shown that of all turbines constructed for a given effective head that with free deviation has the smallest circumferential velocity; it must not, however, be concluded from this that for a given power turbines of this class have necessarily smaller diameters than reaction turbines, as in order to insure the free deviation of the water between the vanes a certain amount of space not occupied by water must be left to which the atmosphere has access.

The paragraph in which the author treats the question of the so-called effect of centrifugal force on radial turbines is very clear and ought to render any misconception on this point in the mind of the student impossible; the author considers that the use of the expression centrifugal force in connection with turbines has led to a good deal of confusion, and he avoids its use.

With regard to centrifugal pumps the Rittinger form of vane is shown to have given the best results of any hitherto tried, although the author thinks it probable that a vane curved still more in the direction of rotation, that is with its concave side acting on the fluid, might give a still further improvement. The work does not, and is not intended to, enter into constructive details other than the form of vanes, diameter of wheel, and area of orifices.

A thoroughly exhaustive and at the same time practical treatise on turbines has yet to be written. The losses due to friction and other resistances have an important effect in diminishing efficiency; these losses may be reduced in two ways, by making the velocity of flow in various parts of the turbine smaller and by improved workmanship (smooth surfaces, &c.); the first of these results can be attained by modifying the proportions of the areas of the various passages, but with the assumptions usually made as to the entrance and exit of the water this is only possible to a very limited extent; it is the question whether by sacrificing partially theoretical considerations, practical advantages might not be obtained more than counterbalancing the losses due to non-observance of the conventional theoretical conditions.

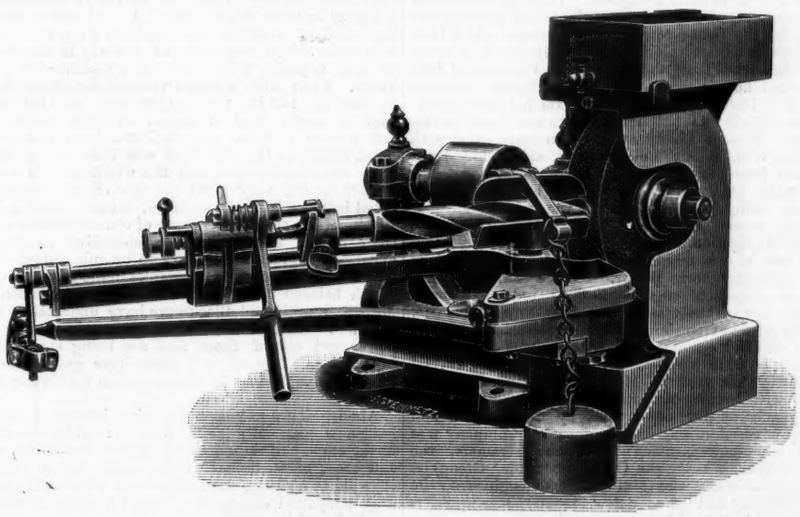
Expansion of Structures by Heat. By J. Keily, C.E. London: Crosby Lockwood and Co.

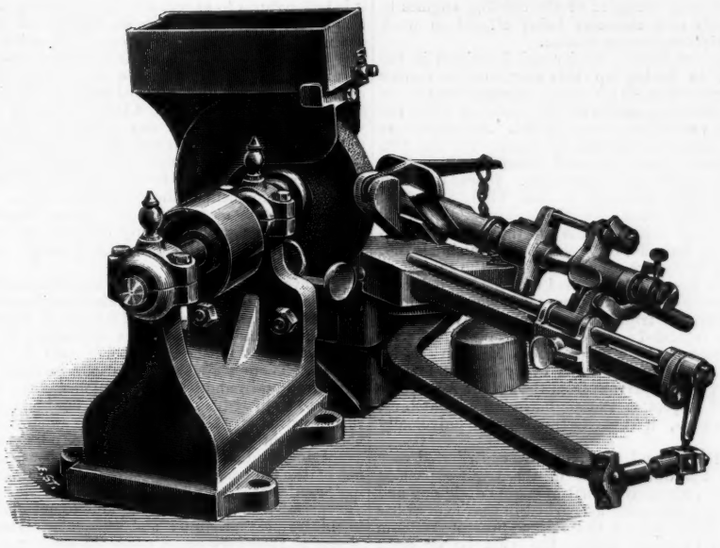
The subject of this book is an interesting one, and worth a good deal of inquiry. The author arrives at two important results: (1) that a structure composed of the same material throughout, expands and contracts in similar figures when the temperature changes in such a way as to keep all parts at a like temperature, and is therefore not strained by such changes. This principle admits of short and simple proof; the proof given covers about twenty pages. The second is that the expansion and contraction of the parts of iron structures exposed to the maximum difference of temperature possible at any one time (viz., full heat of sun's rays to complete shade) do not exceed $\frac{1}{64}$ in. in bars of 5 ft. length, which is considered a practically admissible inequality in the length of bars. The conclusion is that iron structures composed of iron bars not exceeding 5 ft. in length are not likely to be unduly strained by exposure to sun and shade.

Several interesting instances are quoted of the effect of varying temperature on large structures, *e.g.* on the Britannia Bridge and on Southwark Bridge, on the lead roof of Bristol Cathedral, &c.

The value of the book is unfortunately impaired by an error which runs through about one-half of it, viz., in estimating the "force of contraction or expansion by heat" (strictly due to change of temperature) as inevitably occurring upon mere change of temperature, *i.e.* without reference to the question of whether the contraction or expansion be free or resisted (the force in question being of course only developed to the extent that it is resisted, and being zero if unresisted). This comes out most oddly in computing the work done in (unresisted) expansion, *e.g.* (page 89) a horizontal bar A B is laid on a horizontal table with one end A against an obstacle capable of exerting a resistance P, and is then heated; it seems clear that, except for frictional resistance along the table (of which no mention is made), the whole expansion will take place towards the free end B, no matter how small P be; but the author, assuming a point D of no

BARKER'S TWIST-DRILL GRINDER.





motion between A B, computes the work (supposed) done in the free expansion of the segment D B, towards B and equates it to the work (supposed) done in the expansion of the segment D A (as if free) towards A plus that done against (?) the resistance P, and finds thus a point D of no motion!

PLANING MACHINE.

THE illustration on the opposite page shows a planing machine which has recently been designed and constructed by Messrs. George Booth and Co., Halifax, for a firm of Bombay engineers, and which contains many noticeable features. The machine will admit work 20 ft. long, 5 ft. 6 in. wide, and 5 ft. 6 in. high. The table is 21 ft. long and travels on flat slides instead of vees, as in the ordinary way. The driving pulleys and main gearing are placed on the outside of the standard, so that dirt or planings cannot easily get into the teeth of the wheels or the bearings of the shafts. The driving motion is arranged so that the machine is driven from the back, which enables larger objects to be planed than will pass between the standards.

The cross-slide is of massive construction and is fitted with two tool-boxes, arranged to work either together or separately. Self-acting feed motions in the horizontal, vertical, and angular direction are provided. The vertical feed screws are fitted with adjustable nuts so that any wear of the feed nut can be compensated, a point which is of considerable importance where vertical and angular planing must be done with accuracy. The feed motion is arranged so that coarse or fine traverses may be obtained. The self-acting reversing motion is of an improved kind, the belt rod being carried upon antifriction rollers. The knocking-off lever has rollers on the face which comes in contact with the dogs on the table, and thus the wear and tear is reduced. The feed is regulated and the machine stopped, started, or reversed by the disc placed on the base of the standard, which has a compensating balance weight to counterbalance the weight of lifting rod, &c. The right-hand standard is fitted with a side tool-box, which has a self-acting vertical feed by a separate screw driven from the feed disc. Horizontal and angular feeds can be effected by hand.

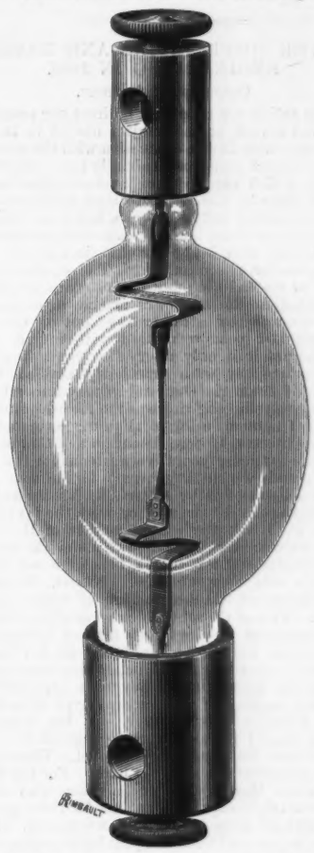
The table is driven by a strong double-stepped rack, actuated by a pinion which imparts a steady motion. The cross-slide is raised and lowered by power by means of screws, bevel gearing, and reversible driving pulleys placed on the top of standard. The approximate weight of the machine is 23 tons.

BARKER'S TWIST-DRILL GRINDER.

THE twist-drill grinder illustrated above is the invention of Mr. E. D. Barker, and is made by Messrs. A. H. Bateman and Co., Limited, of East Greenwich. The drill is carried in a V bearing, in which it is held by a weighted cap. At the other end it is guided by a centre, on which is mounted the lever by which the drill is partially rotated in contact with the emery grinding wheel. This V bearing and the headstock carrying the centre are attached to a square bar. The headstock, with its centre, is made adjustable on the square bar to suit different lengths of drills, and is provided with a screw by means of which the centre, and the drill guided by it, can be fed forward while the grinding is being done. It is also provided with an adjustable stop, which defines the amount of feed for both sides of the drill so as to insure that both sides shall be equally ground. The lever, by means of which the drill is partly rotated, is also connected to a shaft, which runs parallel to the drill, and is coupled by a lever and link to a fixed point of the framing. The bar to which the V piece and headstock are attached is free to oscillate round a point near the V piece. The result of this arrangement is, that when the hand lever is worked so as to rotate the drill, the rear end of the drill, which is guided by the centre, has an oscillating movement imparted to it, and by this means the required clearance is given behind the cutting edge of the drill. In order to grind the centre of the drill to a correct chisel point, the point or centre near the V piece, from which the oscillating movement springs, is so arranged as to allow a slight supplementary movement, towards and away from the grinding wheel, to be imparted by a small crank, not shown in the illustrations. In this way drills varying from $1\frac{1}{2}$ in. to $\frac{3}{32}$ in. in diameter can be accurately and truly ground. A strong feature of the arrangement is the short time taken to master its working. The adjustment for wear of the emery wheel is simple and certain, and the comparatively simple construction enables the machine to be sold at a very reasonable price. Such a tool should materially increase the use of twist-drills.

THE BERNSTEIN GLOW LAMP.

IN a recent number (page 15 *ante*) we gave an account of the Bernstein system of electric lighting, and we now supplement this by an illustration of the glow lamp. The carbon conductor is very substantial, far too much so to be called a filament, and is held between clamps connected to broad copper strips which are bent into zig-zag form to give the fullest freedom to the dilatation of the glowing rod. The globe has at each end an insulated brass cap with a



hole in the side of which the external insulated conductor is inserted, and secured by a binding screw. The lamp gives 35 candle-power with a current of 10 ampères and an electromotive force of 10 volts.

We have so recently described the switch and cut-out used in connection with this system of lighting that it is unnecessary to do more than allude to it. An installation can be seen in operation on the premises of the Bernstein Company, Commercial-road, Buckingham Palace-road, S.W.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, January 20.

IT seems probable that steel quotations will be held firmly at 38 dols. to 40 dols. Offers were made by large buyers this week who wanted from 10,000 to 20,000 tons for summer and autumn delivery at 36 dols. and 37 dols., but their offers were declined for two or

three reasons. In the first place the railmakers do not care to book any more large contracts at any figure, and secondly, the small buyers, many of whom are old customers, are in need of small lots, ranging from 500 to 2000 or 3000 tons, and the makers are reserving their unsold capacity to supply them; third, these small buyers are very ready to pay 38 dols. to 39 dols. or even 40 dols., as has been paid in a few extreme cases. The market is feverish and unsettled at present writing, and it will be some days before any positive conclusions can be drawn. The mills are now taking orders for midsummer, and it is estimated that there are some 600,000 tons yet to be sold, the bulk of which will bring in from 38 dols. to 40 dols. Old material of all kinds is extremely scarce, and the only business done in New York or Philadelphia during the past week, has been at from 25 dols. to 25.50 dols. To day's quotations are 26 dols. firm, and there are buyers for all that can be promptly delivered at that figure. The market for pig iron is very strong and active, and notwithstanding the production is 128,000 tons per week, stocks are exhausted and more business is offered than the furnace interests care to accept. Quotations at Pennsylvania furnaces for tide water delivery given to-day are 18 dols. to 19 dols. for forge; 20 dols. for No. 2 foundry, and 21 dols. to 22 dols. for No. 1. Muck bars are held at 34 dols. to 34.50 dols. Wrought-iron pipe contracts are offered but not accepted. Large orders have been recently placed for locomotive engines numbering some 500 to 600 engines, and it is estimated that almost as many more will be contracted for between now and March 1. This estimate is a moderate one. Merchant bar iron is worth 2 cents to 2.20 cents. Nails have been advanced in both eastern and western markets.

CLYDE SHIPBUILDING AND MARINE ENGINEERING IN 1886.

Concluding Article.

In this article we propose to direct our remarks to the second branch of the subject named in the title. The most notable fact in connection with the work done during the past year is undoubtedly the extraordinary extent to which the triple-expansion engine has been adopted, alike in merchant steamers and in warships of various kinds; and not only so, but it has even been adopted in one of the largest steam dredgers ever built on the Clyde, this being the first instance in which such engines have been employed. The popularity of the engines of the kind in question is something quite unprecedented in the history of marine engineering, for almost every screw steamer sent out of the Clyde shipyards last year was fitted with engines of this kind, and yet it is only a very few years since triple-expansion engines were practically applied in any Clyde-built steamer. Our readers may remember that the first steamship so fitted was the Aberdeen, the first of a line of London and Australian cargo steamers projected by Messrs. George Thomson and Co., of Aberdeen, who for many years were famous for the sailing clipper vessels which they owned in the same trade. That vessel was built by Messrs. R. Napier and Sons, and the engines fitted into her were the invention of Mr. A. C. Kirk, the senior partner of the firm, a gentleman who is well entitled to claim the credit of having been one of the leaders, if not, indeed, the first leader, in this new practice. Messrs. Napier and Sons constructed last year ten sets of triple-expansion engines. Two of the sets, which were of the horizontal triple-expansion type, and of a total of 8500 indicated horse-power, were fitted into the steel twin-screw armour-belted cruiser Australia, which was built for the British Admiralty. They also supplied triple-expansion engines of the vertical type of a total of 12,600 indicated horse-power, for the magnificent Russian citadel ironclad warship, named the Sinope, which is now building at Sebastopol. These are the largest engines of the kind yet built. For the Russian Government Messrs. Napier and Sons also supplied horizontal triple-expansion engines for three gunboats, of a total of 6000 indicated horse-power. In all, Messrs. Napier and Sons last year built engines of well-nigh 28,000 indicated horse-power.

But that total was very greatly exceeded by the Fairfield Shipbuilding and Engineering Company, whose total output of engines is set down at 37,829 indicated horse-power. There were altogether eleven steamers fitted with engines during the year at Fairfield. Two of them, the Trave and the Saale, had each engines of 7200 horse-power; then there were two paddle steamers for the Queenborough and Flushing mail and passenger service, each having engines of 4600 horse-power; there was also the paddle steamer Victoria, with engines of 4747 indicated horse-power, for the London, Chatham, and Dover Railway Company; and we may likewise mention the Orient Steam Navigation Company's new steamer, the Ormuz, which is fitted with triple-expansion engines of 8000 indicated horse-power. If we mistake not, the engines of the Ormuz are the largest of the triple-expansion type yet constructed for a merchant steamer. We ought also to have mentioned that the engines of the Trave and the Saale are of the same kind.

Messrs. James and George Thomson also had a very large output of marine engines. There were no fewer than five sets of engines of 4000 indicated horse-power each, for the twin-screw torpedo cruisers which they built for the British Government, while for the Russian torpedo boat Wiborg they constructed engines of 1300 indicated horse-power; and for the Spanish torpedo vessel El Destructor, engines of 4000 indicated horse-power. Their total output of engines was 25,440 horse-power. Messrs. Denny and Co. (in conjunction with Messrs. Wm. Denny and Brothers, shipbuilders) put engines into nine steamers during last year, the aggregate being 11,895 indicated horse-power, the largest being the engines of the screw steamer Jumna, owned by the British India Association Steam Navigation Company; but these, we may mention, are of the quadruple-expansion type, and of 3415 indicated horse power. Messrs. Caird and Co. had an output of engines of 8900 indicated horse-power, one of the vessels, the troopship Dalhousie, having triple-expansion engines of 2300 horse-power, while another steamer, the Orinoco, was fitted with engines of 6000 horse-power. Five steamers, turned out during the year by Messrs. Scott and Co., were fitted with engines of a total of 8700 horse-power, and the year's output of engines by the London and Glasgow Shipbuilding and Engineering Company was 7800 horse-power, fitted into three steamers, the largest of them being the China tea trader Glengyle. It is probable that the total output of engines on the Clyde during last year for new steamers was upwards of 170,000 indicated horse-power; but there were likewise a number of examples of the existing engines in comparatively new steamers being altered to work upon the triple-expansion system.

Not only have Messrs. Napier and Sons been in the very front in taking up this new line in marine engineering practice, so far as the mercantile marine is concerned, but they also have the credit of being the means of persuading the British Admiralty to adopt the same construction of engines for the two belted cruisers, Australia and Galatea, which they contracted to build in the year 1885. It was intended that all the five warships of that kind, for which tenders were then asked from private shipbuilding firms, should be fitted with engines of the ordinary compound type; but the representations which Messrs. Napier and Sons were able to make on the subject to the Lords of the Admiralty, had the effect of inducing them to resolve that all the five vessels should be fitted with engines of the triple-expansion type. That resolution may be regarded as a very great compliment paid to the eminent firm which embraces Mr. Kirk as its leading partner; and there is every reason for believing that this departure from the recent Admiralty practice, in respect of the engines for new warships, will very soon, if not forthwith, be universally followed.

Messrs. Denny and Co. have also contributed very largely to the development of the triple-expansion engine, the progressive spirit in engine designing and construction being quite as marked in that firm as has been the disposition of the related firm of William Denny and Brothers, during the past six or eight years, to take the fullest advantage of mild steel as the material of construction in shipbuilding, in the practical use of which they have certainly been the pioneers. But Messrs. Denny and Co. have not contented themselves with triple-expansion engines, as they have satisfactorily proved that the practical adoption of the principle of quadruple-expansion in marine engines, is attended with even a still greater degree of economy. Some marine engineering firms are scarcely yet disposed to go beyond steam pressures of 140 lb. per square inch, in boilers working in connection with triple-expansion engines; but with Messrs. Denny and Co. a pressure of 160 lb. per square inch is now quite common in working such engines. Their quadruple-expansion engines (the invention, we believe, of Mr. Walter Brock, a member of the firm) are designed for working up to steam pressures of 170 lb. and 180 lb. per square inch; and they have at present in hand both screw and paddle engines which are to work with steam of the first-mentioned pressure, while they also have in hand a pair of ordinary compound engines which are being adapted to the principle of quadruple-expansion, with 180 lb. as the working steam pressure.

It may be remembered, however, that quadruple-expansion engines working at a steam pressure of 180 lb. per square inch are no new thing on the Clyde. Such engines, indeed, have actually been described and illustrated in Engineering. We refer to those of the steam yacht Rionnag-na-Mara, which were constructed by Messrs. Rankin and Blackmore, of Greenock. They are of the six-cylinder disconnective type patented by that firm, and they have given excellent results in practice. On trial, this splendid yacht—measuring 170 ft. by 21 ft. by 13 ft. 6 in.—was driven at the rate of 12 knots per hour, the engines indicating 528 horse-power, making 113 revolutions per minute, and the steam, which had an initial pressure of 180 lb., being expanded twelve times. In the trials for coal consumption a very exceptional amount of economy was registered, namely, 1½ lb. per indicated horse-power per hour of best Welsh coal. A still more convincing proof of economy was obtained with this yacht in a cruise which she made to Norway in the course of last summer, when she ran a distance of 3638 knots. Even with a steam pressure sometimes down as low as 145 lb. per square inch, the consumption of steam coal of mixed average quality did not exceed 1.43 lb. per indicated horse-power per hour, including the coal that was used for steam to work the steering gear and the windlass. In consequence of the very great success of the machinery fitted into the Rionnag-na-Mara, Messrs. Rankin and Blackmore have now in course of construction a set of their patent four-cylinder disconnective quadruple-expansion engines, which are to be substituted for a pair of ordinary compound engines in the yacht Myrtle, which belongs to a well-known Glasgow gentleman. Messrs. Rankin and Blackmore have undertaken that the new engines shall develop nearly double the power got out of those that are being superseded, in the same space, and they have guaranteed to propel the yacht two knots faster than her former best speed.

Almost all the marine engineering firms on the Clyde have now practically fallen in with the ideas involved in the construction and use of triple-exansion engines, and most of them have either made, or at present engaged in making, such engines, or in adapting ordinary compound engines to the new notions as to economical working. With so many busy brains at work, it is but natural to expect that in the process of evolution a very perfect marine engine will by and by result, one which will leave the compound high and low-pressure engine of John Elder as far behind as that engine was in advance of those in use when Atlantic steam navigation became a commercial reality, well-nigh half a century ago. Very few Clyde engineers have as yet felt disposed to make any practical endeavour to follow Mr. Brock or Messrs. Rankin and Blackmore in working out the principle of quadruple-expansion, which certainly seems to be the direction of the engineering development in the immediate future. So far as we can state at present, Mr. James Howden, of Glasgow, seems to be the only other Clyde engineer who has pinned his faith to the principle in question.

Improvements of various kinds are being made here and there in the details of engine construction, all having as their aim economy of labour, of material, or of fuel; and in many instances appliances that were already well-established are being still further improved. There is a widely-felt desire to simplify constructive details and lessen the number of the working parts, so as to reduce friction to a minimum; and in this direction Mr. Kirk, Mr. Brock, and others have been eminently successful. The use of mild steel (both as forgings and as castings) in engine construction is one of the most marked features in marine engineering practice at the present day, and the Clyde engineers are specially fortunate in being able to get their wants in this respect promptly and efficiently attended to almost at their very doors, where the art of steelmaking has been brought to a high pitch of perfection by a number of eminent firms within a very few years.

In respect of speeds on trial and at sea, some of the steamers turned out from the Clyde shipbuilding yards during the year 1886 have already earned an excellent reputation. That is especially true of the Trave and the Saale, both built and engined at Fairfield, and both belonging to the North German Lloyd's, whose fleet of Atlantic steamers will now bear very favourable comparison even with that owned by the great Cunard Company. It is quite true that the Umbria and Etruria, which are the last additions to that company's fleet, are certainly the fastest steamers now engaged in the Atlantic trade, but the other two vessels previously named are almost equal to them in point of speed, and they have quite out-distanced the Alaska, which was until quite recently considered the fastest boat crossing the Atlantic. But the most remarkable bit of work yet done in speed trials with Clyde-built steamers is that in which the speed of the Spanish torpedo vessel, El Destructor, was involved. Exhaustive experiments were made with the vessel by her builders, Messrs. James and George Thomson, in the course of which they used at least half-a-dozen different propellers embracing alterations of pitch and material; and very important results were obtained. The speed in these interesting trials showed the extraordinary range of from 19½ to 23 knots, the latter being a speed which was never before attained by any steamship afloat with complete equipments on board. Very high rates of speed have also been attained by the other vessels launched by the same builders in the course of the past year.

The improvements which have been going on during the past few years in the construction of shipbuilding and marine engineering plant, forced upon builders by sheer necessity, but more especially since steel got

into such extensive use for vessels of all kinds, have neither been few nor unimportant. Such plant as is now in use in the best-equipped establishments renders it possible to manipulate plates and angle bars for the construction of the hulls with such rapidity, that it is now possible for a vessel of almost any dimensions to be built and fitted out ready for sea within a period of twelve months. There is no doubt that the Clyde shipyards and engine shops are now in a condition of remarkable efficiency, owing to the development which has taken place in labour-saving appliances of almost every kind required.

Notwithstanding the reduction in the output of new shipping last year, as compared with that of the preceding year, it is probable that the total value of the year's work turned out was decidedly in excess of that of 1885, which may be accounted for by the addition of marine engines and the high cost of the war vessels built during the year. The cost of new shipping during the year was a variable quantity, ranging up to rather over 16*l.* per ton for a capital cargo-carrying steamer of moderate speed, down even to 9*l.* 5*s.* per ton for sailing vessels. It is certain that prices during the present year will be higher.

MISCELLANEA.

THE exports of tin-plates in the past year for America direct were 128,134 tons, as against 93,460 tons in the previous year, an increase of 34,674 tons, or 37 per cent.

Mr. Edward C. Peek, of the constructive department at Messrs. Yarrow and Co.'s works, has devised a steam-propelled torpedo which is said to possess many advantages over the ordinary weapon.

The experimental practice with the 47-millimetre Nordenfelt guns was continued last week at Vienna. The results of the trials with all kinds of projectiles are understood to have given general satisfaction.

Mr. T. Blashill has been elected superintending architect to the Metropolitan Board of Works, in place of the late Mr. George Vulliamy. The salary is 1500*l.* per annum for sole services. There were forty-five candidates.

Herr Krupp, in Essen, has the honour of paying the largest income-tax in Prussia; his yearly income is put at rather more than five millions of marks (or 250,000*l.*), and the tax amounts to 151,200 marks.

The New York Metal Exchange reports the purchase of 10,000 tons of English pig iron for a New York pipe-maker, to be delivered at 19 dols. per ton, including duty. This price underbids the prices of American iron.

The State telegraphs in Sweden have a cable length of 8508.6 kilometres, and the wires have a length of 21,363 kilometres. The number of stations is 912, and the number of telegrams sent during 1886 amounted to 1,166,634 messages.

On the island of Oland, Sweden, a limited company has recently been formed for the purpose of starting a cement manufactory, of which there are several in Sweden. The new concern is rather on a large scale, the minimum capital being 800,000 kroner.

The electric installation at Messrs. Rhodes' mills, Hadfield, mentioned on page 83 *ante*, was made by the Manchester District Edison Electric Light Company, the engines and dynamos being constructed by Messrs. Mather and Platt, of Salford.

The plans of M. Bordiau, the architect of the Brussels Exhibition of 1880 and the Antwerp Exhibition of 1885, for the Grand Concours International des Sciences et de l'Industrie, to be held in Brussels in 1888, have been adopted.

The return of American foreign trade for 1886 shows that the exports amounted to 713,289,666 dols. and the imports to 663,417,210 dols. As compared with the previous year's return the exports increased 25,000,000, and the imports 75,000,000.

Four of the fleet of torpedo vessels at Chatham dockyard have been floated out of dock, having been completed and prepared for commission. It is expected they will be sent to Portsmouth in a few days to await further instructions.

A *Times* telegram states that it is proposed to increase the carrying capacity of the Rajpootana Railway, either by converting it into a broad gauge system or by doubling the present line. Estimates have been invited for carrying out the work.

The trade of Vladivostock, the commercial capital of the Amur territory, has made great strides in a few years. The imports in 1879 were valued at 2,017,997 roubles; they annually increased until in 1884, the latest return, they reached 4,206,832 roubles.

The Swedish and Norwegian Railway Company, Limited, have just placed an order for 5000 tons of steel rails for their line with Mr. Fried. Krupp, at Essen, and one hundred 25-ton iron ore wagons with the Birmingham Wagon Company, at Smethwick, all of which are to be fitted with the Westinghouse automatic brake.

The *New York Herald* states that the new dynamite gunboat will be completed in eight months, although the contract with the Government has not yet been signed. The boat will not be a seagoing vessel, being only intended for harbour defence, and will not carry coal for cruising.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended January 23, amounted, on 15,386¾ miles, to 1,073,156*l.*, and for the corresponding period of 1886, on 15,257 miles, to 1,053,228*l.*, an increase of 129¾ miles, or 0.8 per cent., and an increase of 19,928*l.*, or 1.8 per cent.

The total exports of Swansea for last year show a slight increase, the deficiency under some heads being more than made up by large increases in others. The coal exports have been practically the same, but a large increase is to be observed in the export of coal from the Cardiff district —91 per cent. more than the year before.

Orders have been received at Sheerness directing the new fast torpedo cruiser Mohawk, 6, 1630 tons, 5600 horse-power, to be completed for commission. The Admiralty have directed her to be armed with six 6 in. steel breechloading guns, and seven 14 in. torpedo tubes for discharging Whitehead torpedoes. She is also to be equipped with a strong armament of machine and quick-firing guns.

At the first meeting of the Commission of the Melbourne Centennial Exhibition it was decided that the Exhibition should be opened on August 1 next year, and should remain open for six months. The exhibits are to comprise processes of manufacture as well as finished articles. Space is to be provided free of charge, subject to the control of the Commission.

Mr. Forwood, speaking at Ormskirk, said so strongly was it felt that encouragement should be given to British vessels that negotiations had been commenced at the instance of the present Board of Admiralty, and would, he thought, be carried to a successful issue, whereby the services of the most suitable British steamers would be held at the disposal of the Government by the payment of a moderate annual subvention.

New arrangements are announced with regard to the American mails. In future, the White Star Company will take the mails on Wednesdays, the Cunard on Saturdays, the North German Lloyd on Thursdays, and the Inman (for those who wish) on Tuesdays. Thus a mail from New York will leave on four days of the week, and the advantages of the Queenstown and Southampton routes are equally secured.

As a result of the committee presided over by Sir Evelyn Wood, which recently met at the War Office to report upon a repeating rifle which had been submitted to the military authorities, orders were given on Monday for experiments to be made with the weapon, at as early a date as possible. In the first instance parties will be sent to the Hythe School of Musketry that the men may be made familiar with the mechanism of the weapon.

The Royal Castle at Stockholm has already been lighted by electricity for a twelvemonth or so, but on the occasion of the grand ball given on the king's birthday, a week or two ago, the lighting was exceptionally brilliant. An extra engine had been fixed, driving two additional dynamos. In the apartment known as "The White Sea," the number of lamps had been increased by 42 new arcs, making a total of 172 lamps with 2750 candle-power, and the electric light was here of very great effect.

The arrangement of the new Intelligence Branch of the Admiralty is now almost completed. It is understood that Captain W. H. Hall has been appointed director, and Captains Custance and Eardly Wilmot, assistant-directors, and other members of the staff are Major Poe (Royal Marines), Commander R. O. B. C. Brenton, R.N., Commander Dickinson, R.N., Lieutenant Hay, R.N., Lieutenant Marriott (Royal Marines), and Lieutenant Aston (Royal Marines).

The clearances of tonnage from the port of Swansea were last year 4560 vessels of 1,174,026 tons net register, an increase of 10,000 over the previous year; of this number 194 were of 1000 tons net register and upwards, as against 139 in 1885, or an increase of 39 per cent. in number, and 25.73 in tonnage. The total imports and exports for the year amounted to 2,406,297 tons. The total revenue reached 101,001*l.*, as against 100,494*l.*, leaving an accumulated surplus in hand, after paying interest and all charges, of 25,385*l.*

A contemporary states that the Admiralty have been represented in the American mail conferences, and contracts by anticipation have been made for the services of the great Atlantic liners for war purposes at peace prices. The White Star Company have not built any new vessels for a long time, and now they are to receive an annual subvention in consideration of their new ships, which are to be the largest and fastest afloat, being built in accordance with Admiralty designs, a return to the practice of fifty years ago. Similar arragements are under negotiation with the Cunard and Inman Companies.

The Plymouth correspondent of the *Standard* says that an unpleasant feeling has been caused in Devonport Dockyard by the discovery that the sword-bayonets supplied to a ship newly commissioned, are utterly unfit for use. Placed across the knee, they are bent with ease in two or three places. These weapons have been supplied out of store, so that it is probable other recently commissioned ships have them on board. Those tested were taken indiscriminately from a rack, and Admiral Phillimore has forwarded one to the Admiralty. It is expected that a thorough examination of all bayonets and cutlasses in store and on board Her Majesty's ships will be made.

The Trent (Burton-on-Trent and Humber) Navigation Company (Limited), has been formed for the expeditious carriage of merchandise and minerals by water between Burton-on-Trent, Nottingham, Newark, Gainsborough, and other intermediate places, and Hull and Grimsby. The prospectus says that a provisional contract has been entered into for acquiring the existing powers, lands, plant, and property of the Trent Navigation Company, also for perpetual use of the Trent and Mersey Canal between its junction with the River Trent near Shardlow and the town of Burton-on-Trent, so as to secure in perpetuity independent access from the Humber to Burton-on-Trent. The capital is 350,000*l.*

A letter from Mr. A. E. Clement Smith contains the following: The Thames fort district includes five forts—Coalhouse Fort, with twenty heavy guns; Cliff Fort, with fourteen heavy guns; Shornmead, with thirteen heavy guns; New Tavern, with fourteen heavy guns; and Tilbury, with thirteen heavy guns and eight 10 in. howitzers. Coalhouse with its twenty heavy guns is served by one commanding officer, a master gunner, and nine men. Cliff and Shornmead Forts are similarly undermanned. At Tilbury there are only twenty men of the 10th Division, Coast Brigade, commanded by a lieutenant. New Tavern, which is the head-quarters of the 10th Division, Coast Brigade, has, besides the staff, only one officer and fifteen gunners.

The funeral of Sir Joseph Whitworth took place last Wednesday at Darley Dale, Derbyshire. It was attended by more than fifty Whitworth scholars, and after the ceremony the following resolution was passed: "The Whitworth scholars now assembled offer to Lady Whitworth, on behalf of the whole body of Whitworth scholars, their sincere and heartfelt condolence with her in her sad bereavement. They wish to take this opportunity of recording their deep gratitude for the benefits they have derived from the noble generosity of Sir Joseph Whitworth in founding the scholarships which bear his name, and to express their conviction that the example of his life and the benefits which his genius has conferred upon the world, will for ever be regarded by his countrymen with feelings of gratitude and pride."

The *Novosti* points out that by the inauguration of the Tchardjui station on the Transcaspian Railway, the whole of Russia is brought into unbroken communication with the Amu Darya. The importance of the Transcaspian line, which is already more than 1000 versts long, is at once strategic and commercial, as the districts around Bokhara and Samarcand are among the most fertile upon the face of the earth, and if their wealth has not hitherto been made full use of it is because the means of communication have hitherto been so defective. No sooner was it known that the Transcaspian Railway would be prolonged to the Amu Darya than the production of cotton in Bokhara increased considerably. This line will also carry large quantities of silks, furs, carpets, leather, wool, fruits, &c.

The River Tyne Commissioners have published an analysis of the trade of the river during the year 1886. The report states that although the trade of the Tyne has suffered from the continued depression in the shipping, yet in commercial and manufacturing industries of all kinds, the loss the revenue sustained was not more than 1½ per cent. compared with the previous twelve months. The imports of the year were 1,312,007 tons as compared with 1,430,726 tons in the previous year, and the exports, exclusive of coal and coke, were 710,499 tons, against 779,097 tons in 1885. The exports of coal and coke were 9,670,328 tons, as against 9,601,835 in 1885. The total exports and imports were 11,692,824 tons in 1886, and 11,811,658 tons in 1885. The total number of vessels cleared outwards from the Tyne in 1886 was 13,555, and the total registered tonnage 6,027,745, against 14,253 vessels and tonnage 6,105,932 in 1885. In shipbuilding there has been a diminution in the amount of work done. It is probable, says the report, that the present year will witness improvements in this as well as in other branches of business.

Messrs. S. French and B. M. Plumb, of 36, Lombard-street, E.C., the European agents of the Cowles Electric Smelting and Aluminium Company, of Cleveland, U.S.A., are showing two interesting samples to illustrate the beneficial effects of the addition of small quantities of aluminium to steel. Each specimen consists of a bar of iron, and a bar of Siemens-Martin basic steel welded side by side and broken off. In one specimen, however, the steel contains one-fifth of one per cent. of aluminium, while in the other the metal is of the ordinary quality. In the latter case the position of the weld is clearly visible, there being a clear line between the crystalline structure of the iron and the fine grain of the steel. But in the former sample no such line is to be seen, and the characteristics of the steel appear to extend far into the iron, rendering it impossible to tell by the appearance where one ends and the other begins. The same firm have also a forged bar of aluminium bronze, containing five per cent. of aluminium, which has broken in the testing machine at a strain of 36 tons per square inch of original section, and with 60 per cent. elongation. A bar of this metal forged, bent, and broken in company with a similar bar of Siemens-Martin basic steel, exhibited characteristics identical in every respect except colour.

STEAM ENGINES IN SWEDEN.—In Sweden steam engines have hitherto been without any Government control whatever, but orders have now been given to the magistrates to send in, before March 15, a list of all steam engines in their district, with full report of age, kind, &c. In Norway no steps have as yet been taken in this direction.

A NEW SAFETY MINING CARTRIDGE.—In the letter of Mr. Walton Brown, which appeared in our last issue, the figure 38 was converted by a printer's error into 38,000. The object of the letter was to prove that it is impossible to raise sufficient pressure by the application of sulphuric acid to zinc to be useful in coal-getting, and that instead of a pressure of 37,000 atmospheres as claimed, only 38 atmospheres could be attained.

ARRANGEMENT OF ENGINES AND BOILERS OF THE STEAM YACHT "GLADIATOR."

CONSTRUCTED BY MESSRS. RAMAGE AND FERGUSON, ENGINEERS, LEITH.

(*For Notice, see opposite Page.*)

Fig. 1.

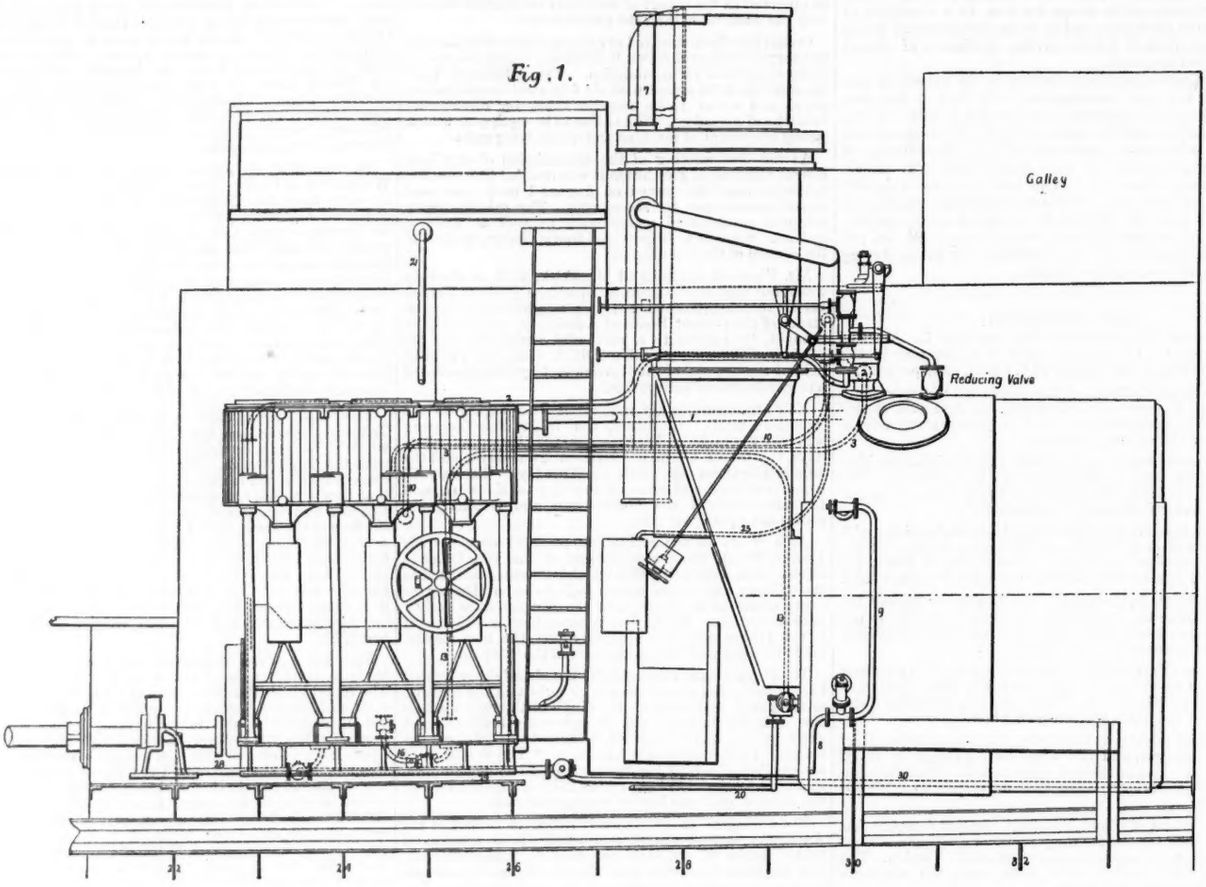
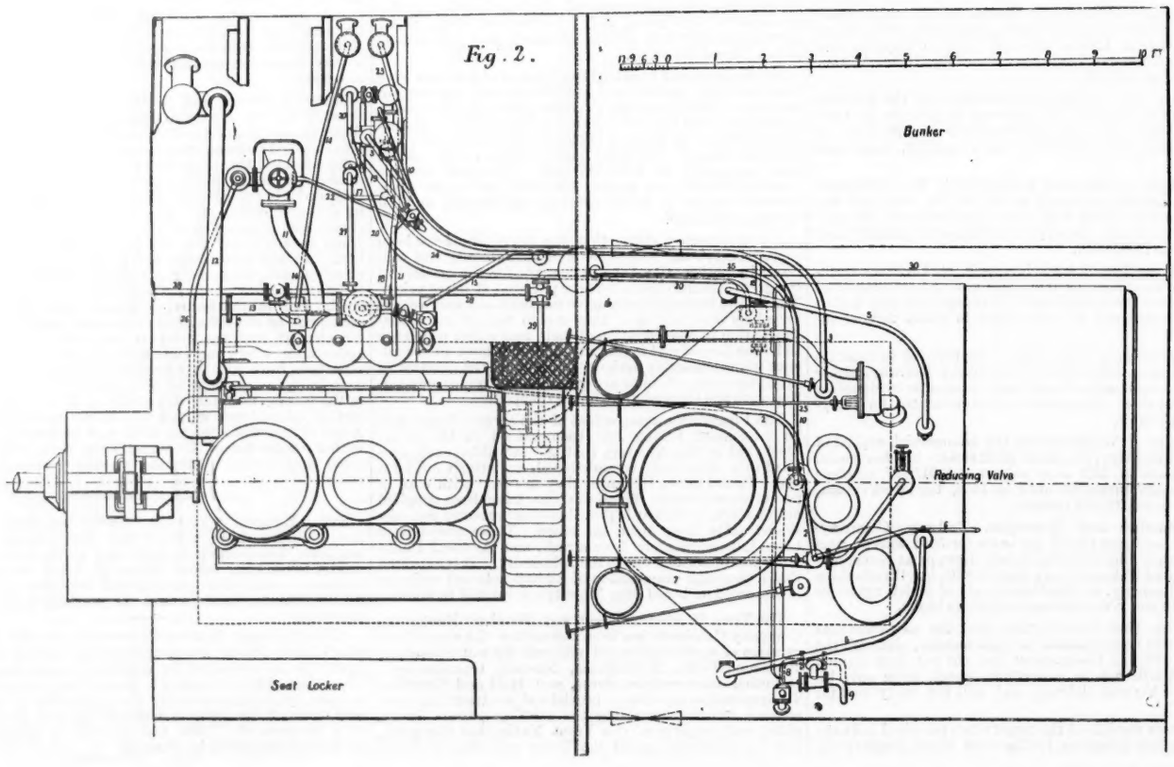


Fig. 2.



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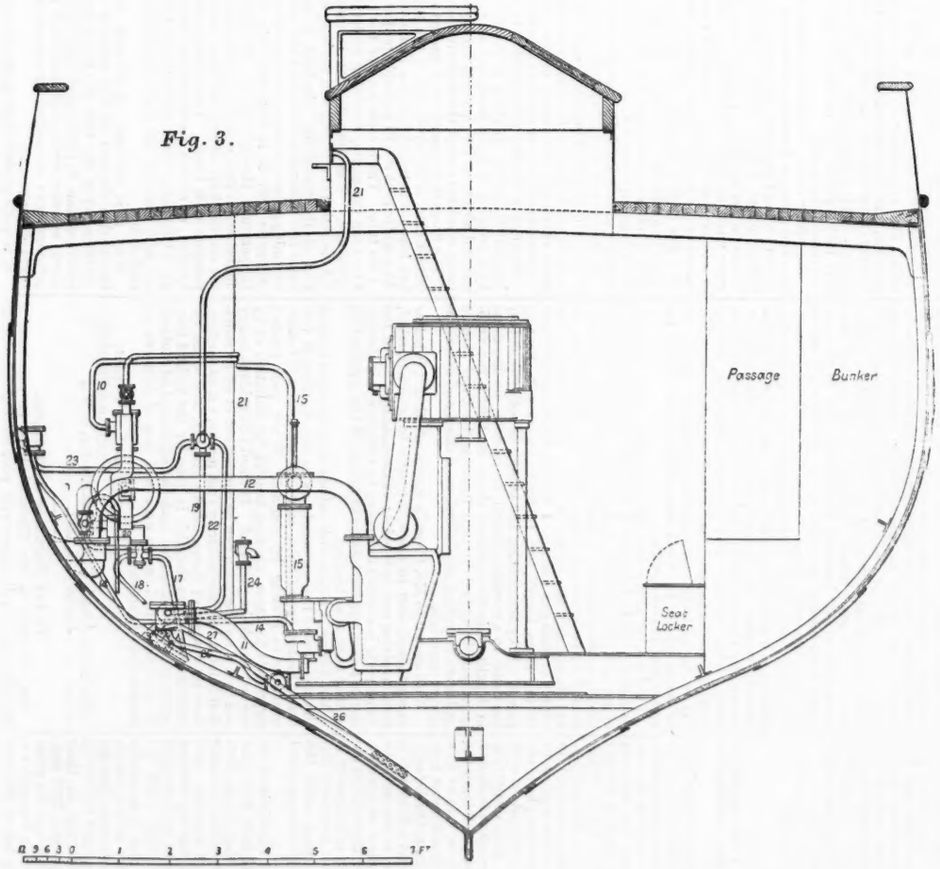
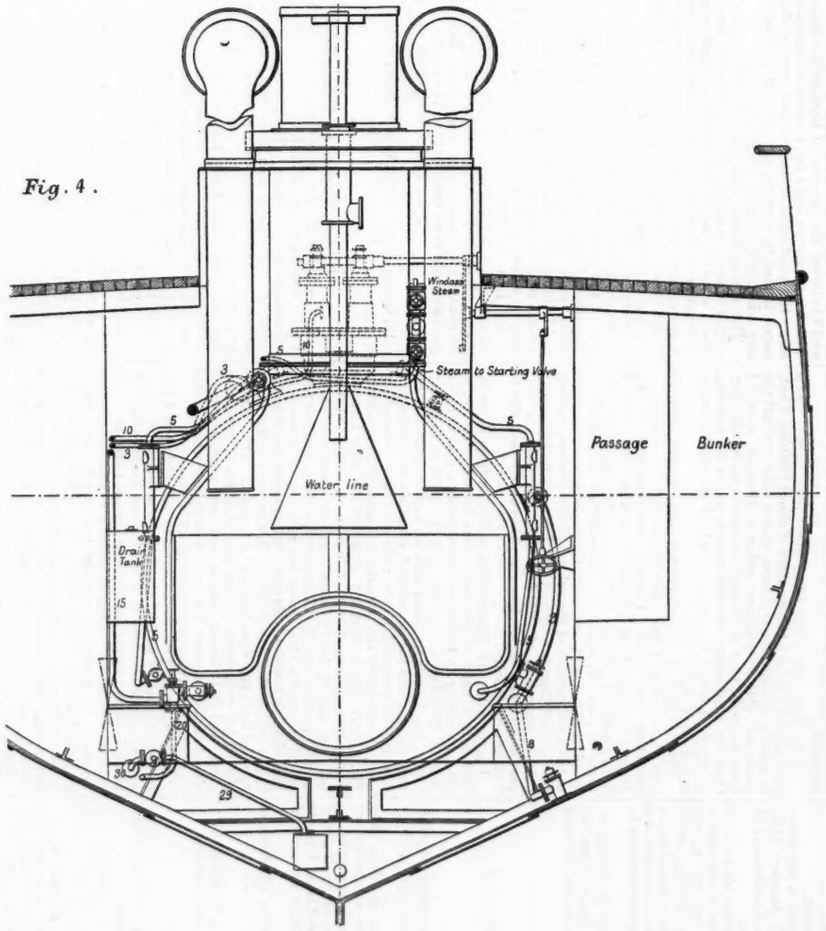


Fig. 4.



WE give on the present and opposite pages views showing the general arrangement of the triple-expansion engines and boilers of the steam yacht Gladiator, which, with her machinery, has been constructed by Messrs. Ramage and Ferguson, of Leith, for Mr. Richard Martin. We shall, in an early issue, publish further illustrations of the engines of this vessel, and for the present, therefore, we postpone giving a detailed description.

STREET'S INDIAN AND COLONIAL MERCANTILE DIRECTORY.—The eleventh issue of this valuable work fully maintains the reputation of its predecessors. In addition to the usual information, the present volume contains particulars of the steam, postal, parcel post, and other communications with the various places treated of. The leading merchants and traders are, of course, given, and also the leading professional men. The principal products of each country are named, with statistics of the trade done in them. All the London agents to each of the banks have their names and addresses published. Particulars of the various railways in operation or in course of construction are arranged under a separate heading. The entire volume has been brought up to date, and under the increased interest which is being felt in our colonial empire, will be more necessary both to the trader and the politician than ever.

SUPPLEMENTARY CATALOGUE OF THE NEWCASTLE-ON-TYNE PUBLIC LIBRARIES.—The people of Newcastle are to be congratulated upon the zeal with which their chief librarian, Mr. W. J. Haggerston, prepares the catalogues of the public libraries. He not only gives them a list of books, but going beyond all alphabetical arrangement, he acts as the guide and friend of the reader, and informs him what books treat of the subject in which he is interested. For instance, in a supplementary catalogue just published, he provides the engineer with a syllabus of the contents of all the volumes of the Proceedings of the Institution of Civil Engineers; to the electrician he gives the titles and dates of many leading papers on his subject published in periodicals; on the Egyptian question he offers a third of a page of small type references to scores of works which ninety-nine readers out of a hundred would never have found without this aid, and so on. The value of a library is increased tenfold by such a guide to its contents.

INSTITUTION OF CIVIL ENGINEERS.—The Birmingham Association of students of this Institution held their first meeting at the Colonnade Hotel, Birmingham, on Thursday, January 27th, to hear a paper read by Mr. R. Peirce, Stud. Inst. C.E., upon the "Kidderminster Sewerage and Water Supply." Mr. E. Pritchard, M. Inst. C.E. (the President), was in the chair, and congratulated the Association upon the number of members and friends present, which, he thought, augured well for the success of the Association. Mr. Peirce gave a very interesting description of the past and present sanitary condition of Kidderminster. In 1874, he said, 100,000*l.* was spent on sewerage and water works, and these works were at the time believed to be efficient. A severe epidemic of typhoid fever in 1884 suggested that they were not satisfactory, and a Local Government Board inquiry brought to light facts showing that the works had been very carelessly carried out. To remedy matters the Corporation adopted and carried out an improvement scheme. The paper was illustrated by plans, diagrams, and photographs.

TESTING DYNAMOS.

To the Editor of Engineering.

Sir,—My attention has just been directed to the letter on "Testing Dynamos" in your issue of January 14th, which relates to a method of determining the efficiency of a machine by electrical measurements only.

The efficiency, however, arrived at by the above is of little or no value, since no account is taken of the power required to overcome the resistance of the air to the rotating armature and the friction of the bearings when running at the speed given. These items depend upon the build of the armature and the mechanical construction of the machine, and constitute a very important factor in the efficiency.

Let w=the mechanical power (expressed in watts) required to run the armature at the given speed when the electrical circuit is disconnected, then employing the same lettering as Mr. Fuge, the efficiency

$$x=\frac{E\,C}{W+w}$$

when the series machine is run as a dynamo, and

$$x=\frac{W-w}{E_1\,C}$$

when run as a motor.

To determine correctly the commercial efficiency by this method, we must have recourse to a brake measurement of the power w.

Now the method devised by Captain Cardew, who employs two additional machines, arrives at the correct commercial efficiency by electrical measurements only.

Mr. Fuge's method gives what is known as the efficiency of conversion. This may be very high, and is as high as 98 per cent. in some machines, while their commercial efficiencies may be much lower.

Stating the above, therefore, simply as the efficiency of a dynamo, gives a wrong estimate of the same.

Yours truly,
H. D. Wilkinson.

School of Electrical Engineering, Hanover-square.
January 27, 1887.

DISSOCIATION IN THE STEEL FURNACE.

To the Editor of Engineering.

Sir,—Referring to the remarks in my letter on St. Claire Deville's dissociation hypothesis, I should be glad if any one who has seriously studied the subject, could direct me to any published description of exact experiments relating to the dissociation of gases. I know of the following experiments, but these have reference to the dissociation of solids, viz., those of Ditte, Debray, and Frost, and Hautefeuille, all published in the *Comptes Rendus de l'Académie des Sciences*, the studies of Isambert elaborated in his "Thèse de Doctoral" (*Annales de l'Ecole Normale*), as well as the published articles by Berthelot and his confrère Vieille, and Jamin and his collaborateur Bouty, and St. Claire Deville's new classic "Leçons sur la Dissociation;" but I am not aware that any definite experiments have proved the truth of Deville's dissociation hypothesis when applied to gases, but still such may exist.

Yours faithfully,
B. H. Thwaite.

37, Victoria-street, Liverpool, January 24, 1887.

To the Editor of Engineering.

Sir,—In your issue of the 14th inst. there appears a letter from Mr. Crowe replying to my letter published in your issue of the 31st ult.

It is possible that the variations in temperatures of dissociation as determined by different investigators may be partly due to the greater or less amount of dissociation obtained by them. But Mr. Crowe is mistaken in supposing that Bunsen's experiments indicate the ultimate temperatures of dissociation for carbonic acid or steam; for they only indicate the temperatures below which that eminent physicist did not observe dissociation. Bunsen operated upon explosive mixtures confined in cylinders, and by noting the pressures of the explosions he determined the temperatures of combustion; he made successive explosions of the mixtures contained in each vessel, until all the gases had combined, thus disproving Mr. Crowe's suggestion, that at the temperature indicated "no combustion or combination would be possible, as the heat would be sufficient to hold the whole volume in a state of dissociation." I am of opinion that Bunsen mistook imperfect combustion for dissociation, notwithstanding the high temperatures obtained by him; dissociation has always been found to be partial, and it can only be partial, if its real cause, so far as determined at present, is taken into account, for the amount of dissociation obtained by different investigators in their experiments is mostly due to contact with hot surfaces. Complete dissociation could only occur in an open space under the direct action of heat alone, and the temperature required for that purpose has not yet been attained.

As to the quotations from Mr. Dugald Clerk's book on the gas engine given by Mr. Crowe, "If it be true that the cold surface of the vessel is the limiting cause, then the maximum pressure produced in exploding the same gaseous mixture, in vessels of different capacity, will greatly vary. When the vessel is small and the surface therefore relatively large, more heat should be abstracted and lower pressure should be produced. This is not the case. The maximum temperature produced by an explosion is almost independent of the capacity of the vessel. This hardly agrees with Mr. Siemens' statement that the difference in the shape of the vessels employed by Deville and Bunsen accounts for so much difference in their results as that between 1000 deg. Cent. and 2400 deg. Cent. amounts to." But Mr. Crowe here misses the point of my argument which referred to repeating Bunsen's experiments in vessels of the same capacity but of different forms, and not in vessels of the same form but of different capacities.

In another part of his letter Mr. Crowe says: "In a gas engine cylinder a temperature of about 1600 deg. Cent. is usually attained on explosion, where only one-half the gases are able to combine, owing to dissociation, and I have no doubt that at Bunsen's temperature of 2400 deg. Cent. no combustion or combination would be possible, as the heat would be sufficient to hold the whole volume in a state of dissociation."

The last part of this statement rests on Mr. Crowe's own views, which I have already shown to be erroneous: the other part is Mr. Crowe's interpretation of Mr. Dugald Clerk, and not a quotation from his book, which I have examined without finding any reference to dissociation, on page 27, where the temperature of explosion is given at 1600 deg. Cent. Mr. Clerk devotes some pages to the consideration of the subject of dissociation, quoting Deville and Bunsen's figures, but I did not find the particular temperature of 1600 deg. Cent. mentioned in that part of his work, which, however, I have only been able to look at superficially.

I agree with Mr. Crowe that radiation from flame increases in a much higher ratio than its temperature, so that, according to Dulong, a flame giving a unit of radiation at 1000 deg. Cent. will give 16 units at 1500 deg. Cent., but I scarcely think that at higher temperatures than those given the amount of radiation would increase in so large a progressive ratio; the quotation given, however, shows clearly the advantage of heating by radiation. Mr. Crowe argues that my experiments with furnaces heated by radiation show that flame is converted by radiation into sensible heat; I do not object to that conclusion, as it is precisely the effect I desire to produce, and this part of his statement also shows the economy of heating by radiation. It is undeniable that heating materials by radiation, *toasting them*, as Professor Lodge very aptly terms it, must be better than heating by contact. This result is proved by experience in the manufacture of steel and glass, and it is shown also in ordinary practice, where closed muffles are used for heating materials which would be spoiled if carried out with contact of flame.

I again agree with Mr. Crowe in admitting that in a furnace heated by contact the flame is increased in length as the furnace becomes more and more heated; but this result is caused by partial dissociation due to contact with heated substances. As just shown, contact of flame is injurious to materials under treatment, and where employed it would be preferable to use fuel (such as carbonic oxide or hydrogen) free from hydro-carbons, so as to prevent the formation of soot on the surfaces to be heated, soot being a non-conductor of heat, besides causing smoke.

It would lead me too far to enter into the question of the distribution of heat in a furnace chamber, which depends on many circumstances; but I may say that in small narrow furnaces, where limited surfaces are to be heated, which would not be injured by contact of flame, a blow-pipe action of a *non-luminous* flame radiating little heat, but striking on the surfaces to be heated, is advantageous; the same remark would hold good in most cases where heat of low intensity is required, but in all cases where large furnace chambers are to be intensely heated a highly luminous flame is required without contact. Under these conditions the furnace will work economically, produce a higher temperature, and will last a long time without repairs, for clay and silica are principally destroyed by the mechanical action of the flame striking on them. This fact has been proved in practice, now extending over three years, and I shall be glad to show Mr. Crowe open-hearth steel melting furnaces heated by radiation which have not been stopped for repairs for upwards of twelve months.

I did not say in my last letter, as Mr. Crowe puts it, that flame will be lengthened by augmenting the amount of gas and air admitted to a furnace. What I said was that I would undertake to lengthen the flame in a furnace heated by radiation by augmenting the supply of gas, or by diminishing the supply of air; by augmenting the supply of both gas and air, I should maintain the flame at the same length, but I should increase its heating power. If by augmenting the supply of both gas and air the flame in a furnace, heated by contact, be increased in length, this circumstance shows that with the additional supply of fuel in such furnaces the flame is more and more disturbed, involving loss of effect and deterioration of materials.

With regard to Mr. Crowe's statement, that it is better to waste heat than to allow the ports to be deteriorated, thus involving cost in repairs; as the deterioration of the flame ports is avoided in heating by radiation this circumstance forms another feature in favour of the application of that method of heating.

Mr. Crowe, I notice with satisfaction, does not contest the accuracy of my arguments as to the working of furnaces heated by radiation, and I do not contest his statements as to heating by contact. What your readers require is to know whether heating by radiation or by contact should be preferred. It should be evident to any one that if an operation can be carried out at all by radiation it must be done better by that means, *i.e. by toasting*, than by contact of flame, *i.e. by burning*, and since experience has shown that this is done for the highest temperatures, and is attended with the additional advantages of economy in fuel and in wear and tear of furnaces, all doubts should vanish.

I am, Sir, your obedient servant,
Frederick Siemens.

12, Queen Anne's Gate, Westminster, S.W.,
January 25, 1887.

To the Editor of Engineering.

Sir,—In reply to Mr. Thwaite's letter in your issue of the 21st ult., I quite agree with your correspondent as to the importance of the investigations made by Berthelot and Vieille on the increase of the specific heat of gases with temperature; but I fail to see how these experiments affect the question of dissociation in regenerative gas furnaces heated by contact, nor does Mr. Thwaite furnish any evidence in support of that assertion.

The circumstance that the air valve controlling the supply of air to a regenerative gas furnace may be partly closed when the furnace is heated to a certain temperature, does not prove that the air supply has been reduced, but it shows that owing to the air regenerator having been heated it acts as a chimney, and draws in air through the valve at a greater velocity than before.

As regards Mr. Thwaite's remarks on the shortening of flames, I have explained this matter in my letter to you of the 25th ult. in reply to Mr. Crowe. But Mr. Thwaite can, by availing himself of the offer made in my letter, published in your issue of December 31st last, satisfy himself by absolute observation that the flame in my gas stove is independent of the chimney draught. I shall be willing to show him the burner which I exhibited at the Iron and Steel Institute, and close the chimney altogether for a short time without in any way altering the length of the flame, the chimney being only necessary for drawing the products of combustion through the regenerator and their removal from the room.

I am, Sir, your obedient servant,
Frederick Siemens.

12, Queen Anne's Gate, Westminster, S.W.,
February 1, 1887.

To the Editor of Engineering.

Sir,—Although the experiments of Berthelot and Vieille may have been refined, they can hardly be termed exhaustive or conclusive. That the specific heat of compound gases increases with their temperature is of course obvious, as heat is absorbed in effecting dissociation; and it is quite possible that the specific heat of simple gases also increases with their temperature to some extent, possibly on account of moisture contained; but to say that increase of specific heat is the main cause of apparent suppression of heat in explosions of gaseous mixtures, is rather a bold statement; the very action of flame and explosions disproves it. Explosive mixtures, no matter of what strength, attain only one-half of their theoretical temperature on explosion; they develop their full heat, but only by the abstraction of heat from the gases after explosion. Supposing the theoretical temperature of a mixture on explosion to be 1800 deg. Cent. it would actually attain about 900 deg. Cent. if increased specific heat of the gases is the cause of only half the heat being sensible, their specific heat at 900 deg. Cent. would be quadrupled; take a mixture whose theoretical temperature is 3800 deg. and actual temperature 1900 deg. Cent., and supposing its specific heat to increase in the same ratio as at 900 deg., its specific heat would be sixtupled, and only one-third of the heat would be sensible; this is contrary to fact, as one-half of its heat is sensible, therefore its specific heat must have remained stationary from 900 deg. to 1800 deg., which I suppose is absurd. It is quite possible that increased specific heat may play a part in the action of explosions, but it does not account for much.

Supposing inert gases to be confined at a high temperature and pressure behind a piston; on their driving the piston forward the expansion curve would rise above the adiabatic line, did the specific heat become lower with decrease in temperature, as the latent heat held by the gases when at high specific heat would become apparent at a lower specific heat, and tend to maintain the temperature of the gases. This actually is the case in an explosive gas engine cylinder, where the gases burn after explosion, and give out their full duty in sensible heat after explosion; but in a hot-air engine cylinder where there is no explosion it is not so, no matter how large the cylinder or how carefully lagged it may be.

In studying the action of flames, it is quite unnecessary to do so in the steel furnace, especially as there appears to be great difficulties in obtaining a flame free from constant changes in its supply of gas and air, and in the temperature of its constituent gases before ignition.

Suppose a fireclay tube about 3 ft. long and 3 in. in internal diameter, carefully protected from loss of heat by a covering of fossil meal, and an explosive mixture of gas and air forced into one end through wire gauze, no air being admitted except the explosive mixture.

The flame of the gases when ignited will probably reach within 12 in. of the open end of the tube; when the tube has become a bright red the flame will reach the end. At a white heat it will probably project 9 in. or 10 in. out of the tube. The hottest part of the tube will be 3 in. or 4 in. from the gauze, becoming cooler again towards the open end. The hottest part is that where complete inflammation is effected, and the temperature of dissociation at its maximum. As heat is abstracted from the flame it is allowed to burn, and the volume of inert gases becoming greater its temperature of dissociation is lowered; otherwise how is it that the tube is not of an equal temperature throughout? it is certain that the flame diminishes in temperature as combustion proceeds. With the specific heat theory the flame would increase in temperature as it burnt. The mixture being perfect before ignition, no carbon particles can be surrounded by inert gases (the flame is not luminous), and yet combustion does not take place in the time of complete inflammation or explosion.

Why is it necessary to advance such abstruse and improbable theories as the abrasive action of carbon particles, when the fact of a flame having a higher temperature than its products of combustion is a simpler and more common-sense explanation of the cause why a substance can be melted by a flame, and not by its products of combustion?

It is quite possible that as the air to the burner became

heated, a smaller quantity could get through in spite of the hotter chimney.

Yours truly,

Middlesbrough-on-Tees. EDWARD CROWE.

ENGLISH *v.* AMERICAN LOCOMOTIVES.

TO THE EDITOR OF ENGINEERING.

SIR,—Several of your correspondents, in discussing the English and American locomotive question, have shown such entire ignorance of the latter that I would like to call attention to a few mis-statements.

"Stoker," in your issue of December 31, 1886, mentions some engines built in this country, with 20 in. by 24 in. cylinders and grates 24 in. wide by 8 ft. 6 in. long. The real fact is that the figures for width have been inverted, and the real size of this grate is 42 in. by 8 ft. 6 in., or 29.75 square feet instead of 17. The firebox is placed above the frames and suspended at the sides by heavy links. In actual practice it is found that ample depth of firebox can be secured provided the barrel is properly raised up. The engines that he speaks of are not track crushers, because the weight is so distributed on five axles that none of them carry more than 25,000 lb. The bar frame, properly put up with reamed taper bolts, is about as durable as any other part of the engine, and its openness is very useful in permitting inspection and oiling without going underneath.

The cast-iron driving wheel is certainly all that can be desired, as it is cheap and durable. These cast-iron driving centres are perfectly reliable, and I have never seen one broken so as to be dangerous. Occasionally one or more spokes may crack on account of bad foundry work, but even then the wheel is not disabled, and is often run for years after the defect is noticed.

The outside cylinders, cast so as to bolt together under smokebox, make a most rigid brace to keep the frames square, and the valve face placed on top is certainly a vastly more convenient device than the inside vertical face.

The rocker arm which transfers motion from link to valve stem requires less attention than any part of the machinery, and the wear from year to year is surprisingly small.

It should be remembered by your correspondents that in this country accessibility commands a much higher premium than it seems to do in England, and the deep plate frames, deep wheel covers, and inside valve faces, which look simple but are really hard to get at, would not be tolerated on any American road.

The inside cylinder is not a new thing in this country, and there are still a few running on our roads, but they are regarded more in the light of dreadful examples than as models to copy from. The conditions of service in the two countries are so widely different that a comparison of performance is very difficult to make, but judging by the American experience with large drivers the ordinary English engine would make a sorry show on our roads.

Mr. Burnett in comparing performance of Philadelphia and Reading 169 with L. B. and S. C. engine neglected to say that the American engine burned anthracite coal. This fuel requires vastly greater grate area than is needed to burn bituminous coal.

Atlanta, Ga., U.S.A., January 17, 1887. G.

TOOTHED GEARING.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "Discipulus," in your issue of 28th ult., is rather too *sarcastic* in his remarks on the earlier editions of Templeton and Molesworth.

Now I have not quoted from *early* editions, but from recent ones—Templeton of 1862 and Molesworth of 1886. Templeton in his preface to edition of 1862 says, "On my return to England recently . . . I was astonished to find that my old compilations published more than thirty years ago were works still called for by the public, although now in a very *antiquated* state through lapse of time."

I have before me his "Millwright's and Engineer's Pocket Companion" of 1832, and I certainly find that the table referring to pitch and number of teeth of wheels seems to be based on the chordial pitch system. But the edition of 1862, "The Engineer's and Millwright's Practical Assistant"—his last I believe—contains tables based on the arc system calculated thus:

$$\frac{\text{Diameter} \times 3.1416}{\text{Number of teeth}} = \text{pitch—of course the arc pitch.}$$

"Discipulus" must bear in mind that we are wiser in this our generation, than were our fathers in theirs. Great improvements have been made, and are still in progress in every branch of science, and works on engineering, chemistry, electricity, &c., written, say, fifty years, or even twenty years ago, cannot be exempt from adverse criticism, when viewed from the advantageous stand-point of 1887!

I believe that in or about 1812, the late Benjamin Hick, of Bolton (the firm is now Hick, Hargreaves, and Co.) began to revolutionise the system of toothed gearing, by introducing his form and proportions of teeth. "*Hick's tooth*" "a thing of beauty, and a joy for ever," almost, to mill-owners, and those in charge of his gearing. Of course Hick's practice took a long time to disseminate in those days, and I believe the work of Professor Willis—the "Principles of Mechanism"—led to the discarding of the chord in favour of the arc system of pitch.

"Discipulus" should not be so hard on Templeton, his early works were in accordance with the practice of the period in which he wrote, and therefore "Discipulus" should have quoted from his *revised* works, and not from *antiquated* ones.

The evil that men do lives after them; the good is often interred with their bones. So let it be with Templeton.

Mr. Guilford Molesworth is, I hope, still in the flesh, and can answer for himself, and explain why it is that in his first edition published in 1863 he gives no rule whatever for finding diameter, pitch, or number of teeth of wheels, although he gives other information concerning them. And why it is that in his seventeenth edition he gives tables for calculating pitches on the chord system, whilst in his twenty-first his tables are calculated for the arc pitch system.

"Discipulus" accuses me of being dogmatic in my assertion as regards the arc pitch. I stated that the arc pitch *is* the basis of Templeton's and Molesworth's calculations. If I had substituted *was* for *is*, I should be stating what was false. Much virtue in *is*.

Yours truly,

Cork, February 1, 1887. R. HARTLAND.

TO THE EDITOR OF ENGINEERING.

SIR,—In following the correspondence in your columns regarding toothed gear in answer to the question raised by "Discipulus," I have been struck by the fact that no reference has been made to the work on "Mill Gearing," by Thomas Box, published by Spon.

In that work there are some statements regarding nominal horse-power, which ought to be deleted; but his remarks on mill gearing, and the proportions of the teeth of wheels, are excellent, as I can testify from having followed them in my own practice for several years.

I can heartily recommend this portion of the above book to "Discipulus."

I have used the proportions given by Box in designing gearing for all pitches up to 8 in. for rolling mill and general purposes, and have never found any trouble with wheels so designed, nor had I ever any cause to deviate from them, except that I have found it better, in pitches above 4 in., to make the total length of tooth=.66 P, where P=pitch, instead of using the formula given by Box.

Also in designing steel wheels or rims, all sizes (except those of the actual teeth), can be safely reduced, owing to the greater strength of steel over cast iron; care of course being taken to keep within the limits of safety, and to preserve as closely as possible a nearly equal distribution of the metal to insure a sound casting being obtained.

Yours truly,

SINCLAIR COUPER.

6, Clayton Terrace, Dennistoun, Glasgow.

TELEGRAPH AND TELEPHONE WIRES.

TO THE EDITOR OF ENGINEERING.

SIR,—There seems at the present time much halting between the two opinions as to whether the public shall see telegraph wires "skied," *i.e.*, hung up high upon posts in the air, or whether these same wires shall be kept warm and dry underground, and that the public shall not see them at all. So far as the point of expedience goes it is absolutely necessary that these wires should exist, but the point is where to put them. The wires of cities and towns of the United States of America do not suffer from the troubles of storms nearly as much as we do with our complicated arrangements in England.

In Chicago, New York, New Orleans, and Philadelphia (a few are underground) the majority of the wires, both telegraph and telephone, are either put upon iron posts well sunk in the ground at a height of 20 ft. or 25 ft., and at spans of 40 or 50 yards. The points at which any difficulty arises is at the street crossings. There the posts are heightened so as to allow the passage of high vehicles or carts.

This system (which from information I only know) seems a course of disposing of the wires at a height, not too high to be subject to the wind, or to be dangerous as a nuisance to the passengers in case of breakage. The small span also reduces the chances of breakage to a minimum.

A system of this kind, perhaps a little costly at first to lay down, would be but a drop in the ocean in comparison to the 3,000,000*l.* estimated to put these wires under ground.

To sum up the total benefits to the public, to the Government, and the private telegraph and telephone companies, would be:

1. Less danger to the public.

2. Greater accessibility to the wires for repairs and putting up. Therefore less danger to the workman and less expense to the companies. These benefits seem to suggest to any thinking person that they are paramount to the highly sentimental grievance which is sometimes urged as to dissymmetry of our fine streets by the imposition of telegraph poles along the curbstones of pathways, and if this system which is found to work so well in the towns and cities whose average areas contain as great a population as the great city of London, it seems to argue a great lack of ordinary reason in the minds of those whose duty it is to cut down expenditure and remedy defects which at present exist in this branch of our great commercial enterprises.

I am, yours truly,

R. COOPER WILLIS.

32, Lincoln's-Inn Fields, W.C., January 27, 1887.

THE TIMBER OF WESTERN AUSTRALIA.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with interest the article in your number of January 21 on "Western Australia," and your remarks upon the timbers of that colony.

Every one must have noticed the splendid logs of karri timber, which, together with a number of railway sleepers of the same, stood at the entrance to the West Australian Court at the late Exhibition. In consideration of its hardness and great durability there is little doubt the karri wood is pre-eminently suited for paving, and I desire to call the attention of those interested in street maintenance to the fact that a portion of the roadway opposite St. Mary's Church, in Kennington Park-road, is paved with this wood, which has now been down over twelve months; it is easily recognised by the brilliant colour which is visible where the wood has been abraded near the tram-rails.

The weight required to crush karri wood is 11,500 lb. per square inch, twice as much as for the pine so commonly used for paving; and as proof of the durability of karri, I may mention that one of the logs at the late Exhibition had lain for forty-two years between wind and tide on the beach of West Australia; this log is now in the timber museum at Kew.

Mr. M. C. Davies, of Adelaide, South Australia, the owner of the karri timber exhibited at the Colonial Exhibition, is prepared to supply karri 9 in. by 3 in. at the rate of 5*l.* per load of 50 cubic feet in London. His London agents are Messrs. G. J. McCaul and Co., Walbrook.

I am, yours faithfully,

OSWALD BROWN, M. Inst. C.E.

27, Great George-street, Westminster, London,
January 25, 1887.

THE USE OF GLYCERINE TO PREVENT FREEZING.

TO THE EDITOR OF ENGINEERING.

SIR,—In your issue of December 31, 1886, Mr. C. Maclaren Irvine asks for information as to quantity of glycerince required when mixed with water to prevent it freezing at zero (Fahr.)

Here, in Moscow, we always used the the following quantities to save our smaller wet gas meters from freezing, viz.:

50-light meter,		60	pounds	Russian.
30	"	40	"	"
20	"	30	"	"
10	"	15	"	"
5	"	8	"	"
3	"	7	"	"

Forty Russian pounds, or one poud, is equivalent to 36½ lb. avoirdupois. In general we reckon a Russian pound about 14.6 oz. avoirdupois.

I cannot remember the exact liquid contents of the various meters, but I know they were of the ordinary English pattern with patent permanent water-line floats, and were made by the British Gas Meter Company, Kingsland-road, N.E., so that your correspondent will be able to ascertain the quantity of water required by each meter from that firm. The proportions of glycerine (pure white) were determined experimentally, and were always found to have the desired result, in preventing the meters from freezing at any temperature not lower than −15 deg. Reamur, = −1.75 deg. Fahr.

In the same number of ENGINEERING in a Note on Russian railways. you speak of a railway being built from Rjew to Pskow. You doubtless mean Rjew-Byazma, which is only about 125 versts long. When I was in Rjew a month or two ago, this line was being energetically built, but I heard there nothing about a line to Pskow. I inclose my card, and remain,

Yours truly,

Moscow, January 4/16, 1887. A. T. S.

JUNIOR ENGINEERING SOCIETY.—On Friday evening, the 14 ult., the second annual dinner of this Society took place at the Holborn Restaurant, and was largely attended by the members and their friends. The chair was occupied by Professor Alexander B. W. Kennedy, the President, who, in proposing the toast of the evening, among other matters, remarked upon the value of such societies and expressed regret that he was unable to be present at the meetings as often as he desired. He was pleased to see from the reports the progress the Society was making, and pointed out that increase in membership alone was not always indicative of advancement; a better criterion being the manner in which the meetings were attended and the discussion sustained. On the following Friday evening the meetings of the sixth session were inaugurated by Professor H. E. Armstrong, vice-president, with an introductory address on "The Relation of Chemistry to Engineering." The address throughout contained very much of interest to the engineer, and proved conclusively how close was the affinity between the two sciences, and showed the essential importance of a due regard for chemistry in making the study of engineering complete. At the close a cordial vote of thanks was passed to Professor Armstrong for his kindness in delivering his valuable address which it is the intention of the Committee to put into print. The further arrangements of the Society for the current session are as follows: February 25, "The Fallacies of Perpetual Motion," by Mr. W. J. Tennant, Grad. Inst. P.A., Member. March 25, "Torpedo Boat Machinery," by Mr. W. C. Smith, Honorary Member. April 22, "Steam Jacketting," by Mr. R. G. Bleasby, Member. May 20, "The Early Training of Mechanical Engineers," by Mr. S. H. Wells, Wh. Sc. Stud. Inst. C.E., Member. June 17, "The Illumination of Lighthouses," by Mr. F. Taylor, Member. September 23, general meeting. Excursions: February 19 (Saturday). Visit University College Engineering Laboratory, by kind invitation of the president, Professor A. B. W. Kennedy. July 13 (Wednesday). Visit the Royal Mint, by permission of the Deputy Master, the Hon. C. W. Freemantle, C.B. Meeting outside the establishment, on Tower Hill, at 2.45 p.m. September 14 (Wednesday). Visit the Beckton Gas Works, by kind permission of the engineer-in-chief, Mr. George C. Trewby. We may add that the honorary secretary of the Society is Mr. Walter T. Dunn, of 64, Reedworth-street, Kennington-road, S.E.

THE DRAINAGE OF THE HOUSES OF PARLIAMENT.

MR. ISAAC SHONE, ENGINEER, LONDON.

(*For Description, see Page* 117.)

Fig. 1.

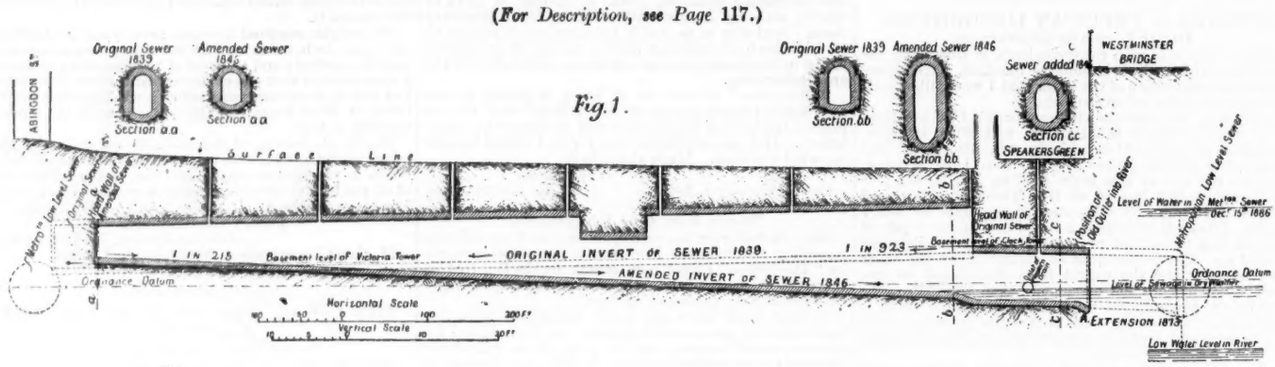


Fig 2.

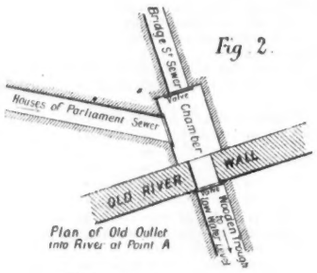

Bridge St. Sewer
Houses of Parliament Sewer
Face of Chamber
WALL
OLD RIVER
Position of Old Outlet into River
Plan of Old Outlet into River at Point A

Fig 4.

Fig 3.

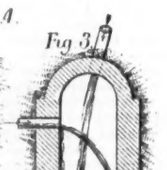


Fig 5.

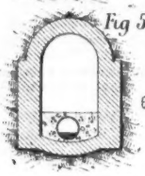


Fig. 10.

Fig. 11.

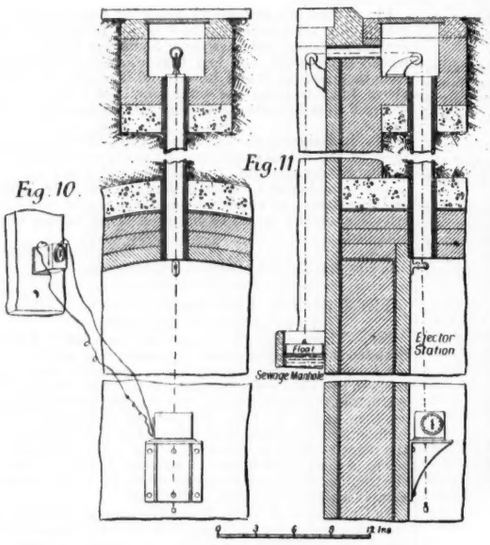


Fig. 12.

Fig 13.

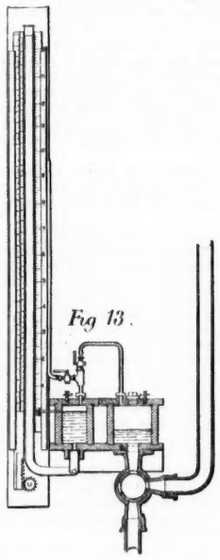
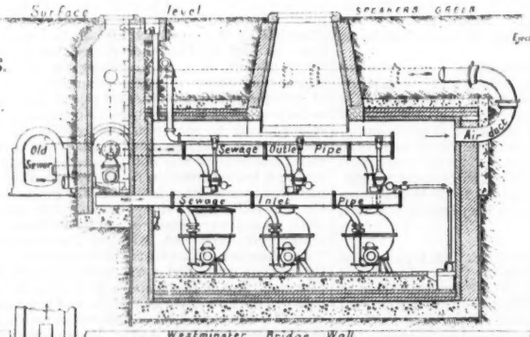


Fig. 6.
Sectional Elevation.



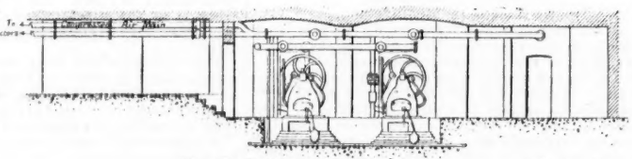


Fig. 8. Sectional Elevation.

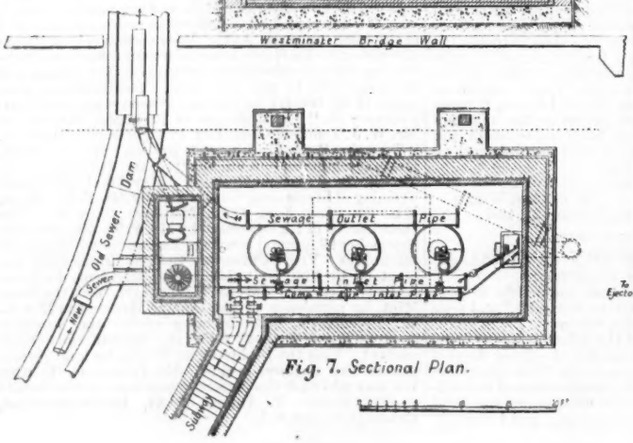


Fig. 7. Sectional Plan.

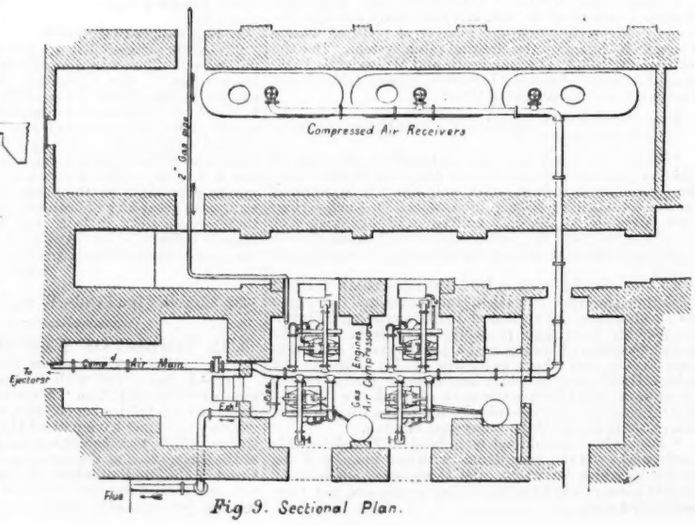


Fig 9. Sectional Plan.

BRIDGE OVER THE IBICUY RIVER; G

MR. ALFRED RUMBALL, M. INST. C.E., ENGINEER; MESSRS. B

(For Description

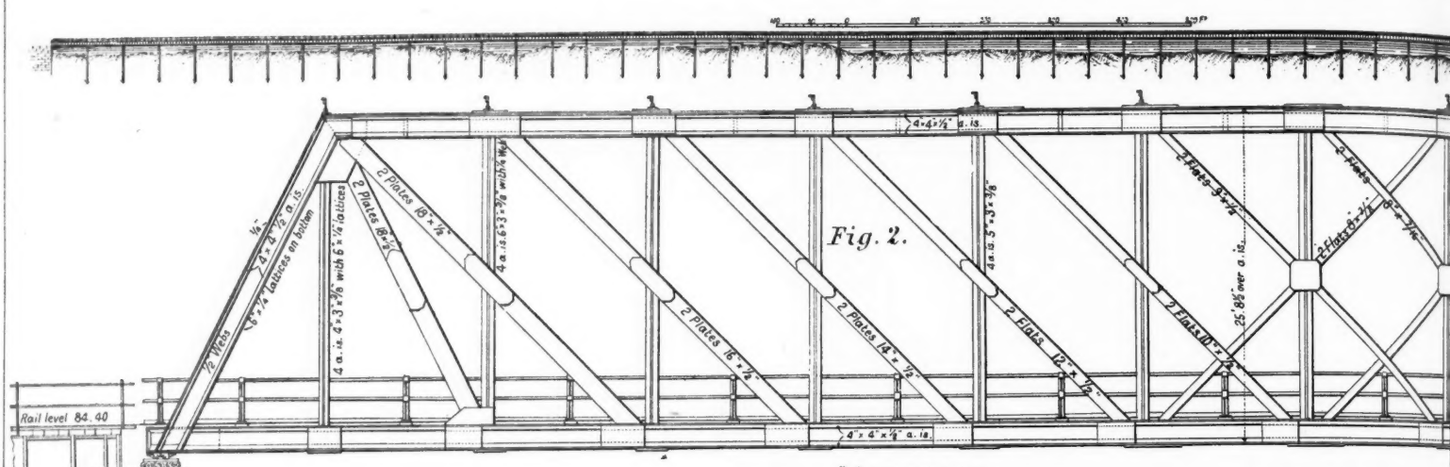

Rail level 84.40
4 a. is. 6"x3"x⅜" with 6"x⅜" lattices
2 Plates 18"x⅜"
4 a. is. 6"x3"x⅜" with 6"x⅜" lattices
2 Plates 16"x⅜"
2 Plates 14"x½"
2 Plates 12"x½"
4"x4"x½" a. is.
25 8½" over a. is.

Fig. 2.

Elevation

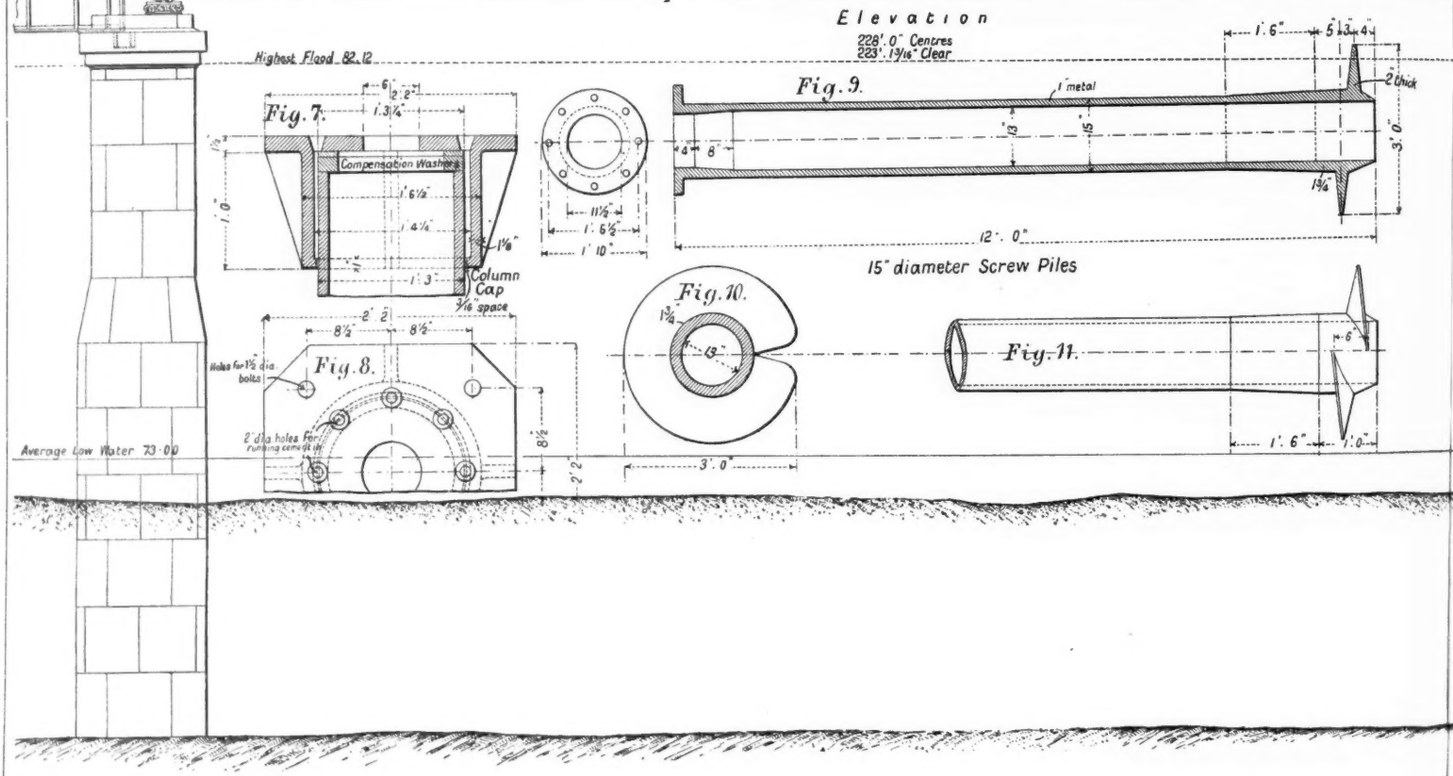


Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

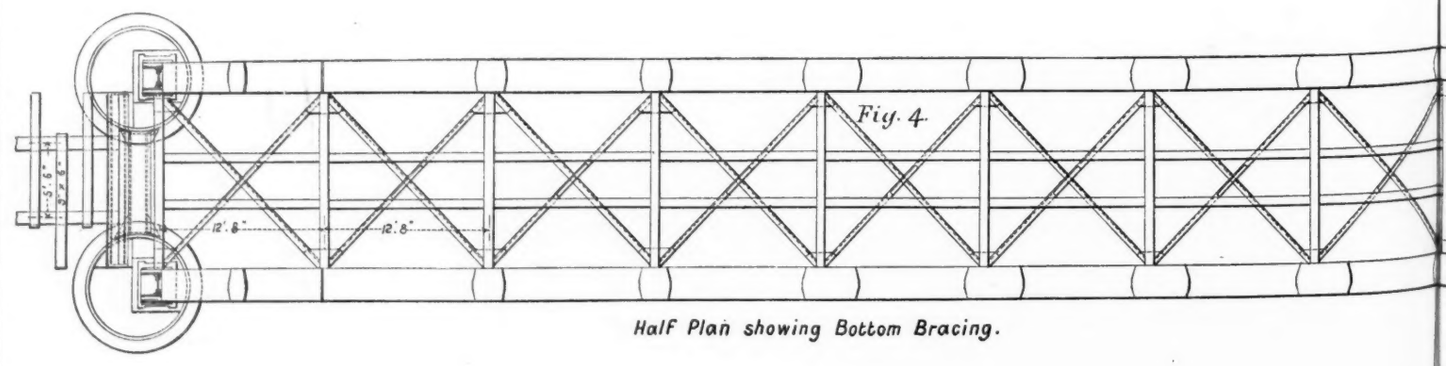


Fig. 4.

Half Plan showing Bottom Bracing.

GREAT SOUTHERN RAILWAY OF BRAZIL.

RS. HEAD, WRIGHTSON, AND CO., STOCKTON-ON-TEES, CONTRACTORS.

cription, see Page 117.)

Fig. 1.

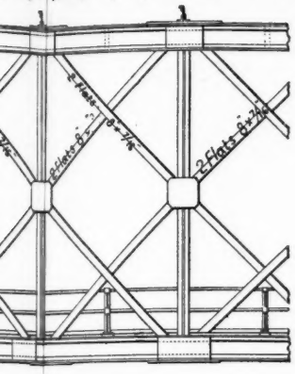
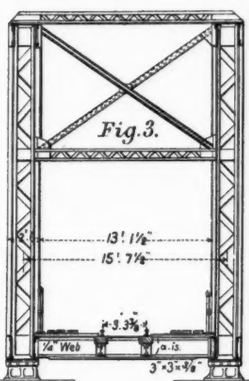
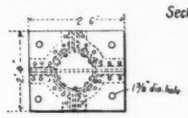


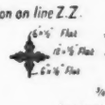
Fig. 3.



Section on line Z.Z.



Detail of 4 Pile Pier.



Section on line X.X.

Fig. 5.

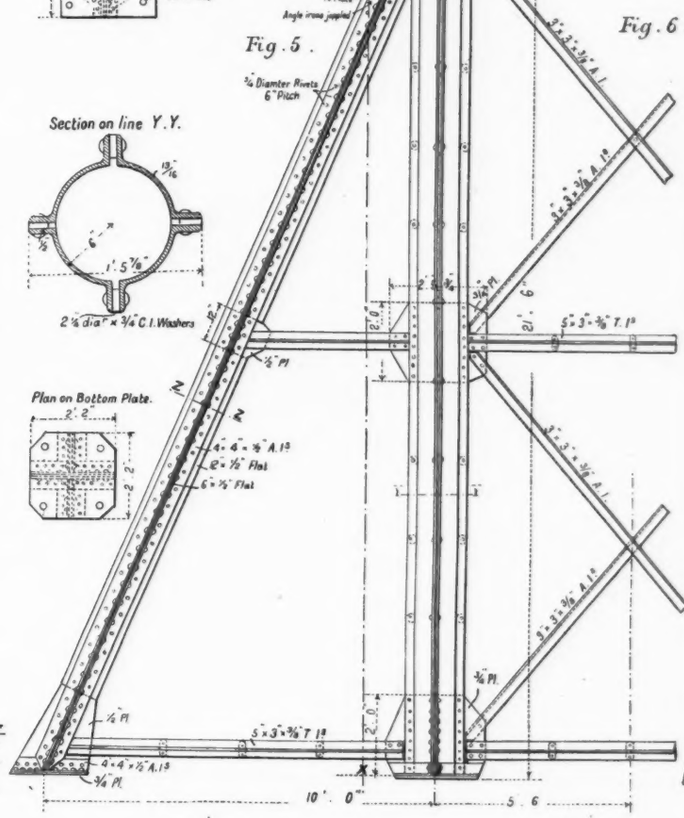
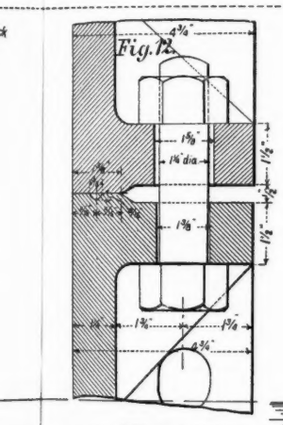


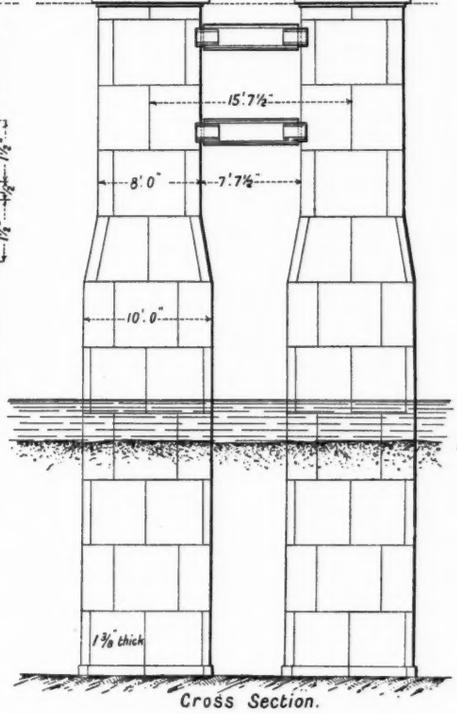
Fig. 6.

Section on line Y.Y.

Plan on Bottom Plate.

Fig. 12.





Cross Section.

Fig. 15.

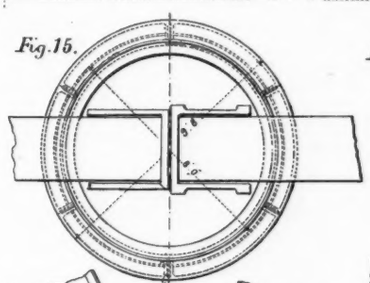


Fig. 16.

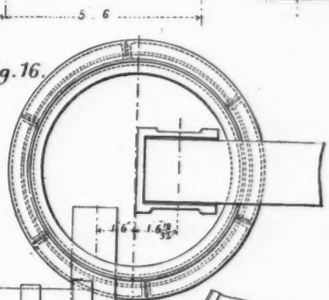


Fig. 17.

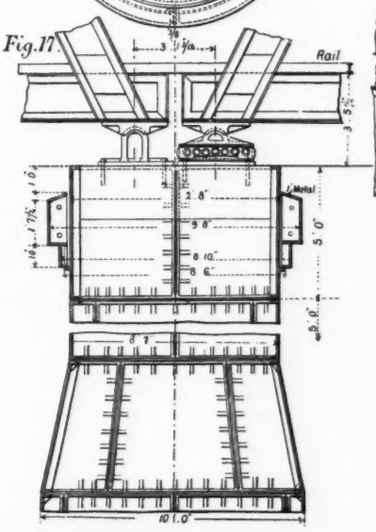
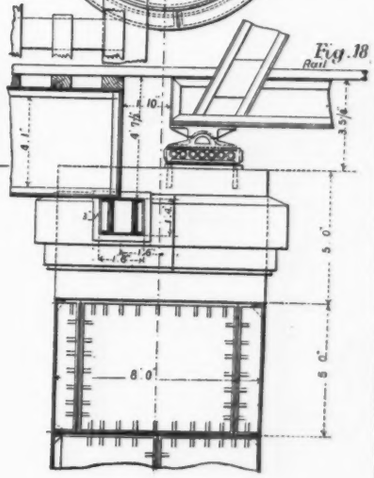
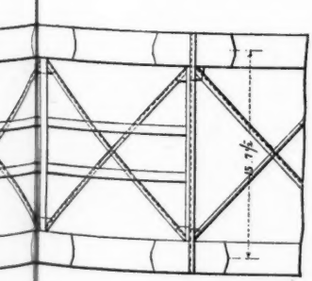


Fig. 18.





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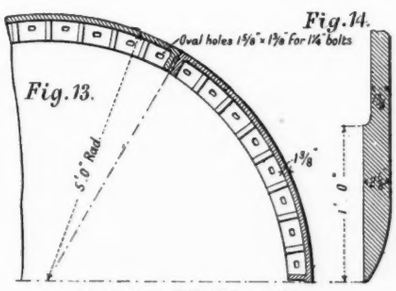

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NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Students' meeting, Friday, February 4th, at 7.30 p.m. Paper to be read: "Recent Researches in Friction," Part II., by John Goodman, Wh. Sc., Stud. Inst., C.E.—Ordinary meeting, Tuesday, February 8th, at 8 p.m. Papers to be further discussed: "Sewage-Sludge and its Disposal," by William Joseph Dibdin, F.C.S., F.I.C.; "Filter Presses for the Treatment of Sewage-Sludge," by William Santo Crimp, Assoc. M. Inst. C.E., F.G.S.

SOCIETY OF ENGINEERS.—Monday, the 7th of February, at the Town Hall, Westminster. The President for the past year, Mr. Perry Fairfax Nursey, will present the premiums awarded for papers read during the year. The President for the year 1887, Professor Henry Robinson, will deliver his inaugural address. The chair will be taken at 7.30 precisely.

THE SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W., Thursday, February 10th. Council meeting at 7 p.m., ordinary general meeting at 8 p.m. "Telephonic Investigations," by Professor Silvanus P. Thompson, B.A., D.S.C., member. Adjourned discussion.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Wednesday, February 9th, in the Lecture Hall of the Subscription Library, Fawcett-street, Sunderland at 7.30 p.m. The following paper will be read and discussed: On "Some Notes on Launching Vessels," by Mr. H. G. Gannaway.

PHYSICAL SOCIETY.—February 12th, 3 p.m. Annual general meeting. "Note on the Tenacity of Spun Glass," by Mr. E. Gibson and Mr. R. A. Gregory.

GEOLOGISTS' ASSOCIATION.—Friday, February 4th, at 7.30 p.m., the annual general meeting at University College, Gower-street, W.C., when the report of the Council and the accounts for the year 1886 will be presented, and the Council and officers for the year 1887 elected. The annual and ordinary meetings will be held in the Botanical Theatre, to as to leave the usual place of meeting free for arranging the exhibits. At the conclusion of the ordinary meeting members will adjourn to the library, where a conversazione and exhibition of objects will be held. During the evening an address will be delivered "On the Recent Volcanic Outburst in New Zealand," by Wm. Lant Carpenter, B.A., B.Sc., illustrated by lantern views. A demonstration "On Agates and their Formation," will be given by Mr. W. J. Abbott, illustrated by nearly 300 specimens.

SOCIETY OF ARCHITECTS.—Tuesday, February 8th, at the Freemasons' Tavern, Great Queen-street, W.C., when a paper will be read by Mr. C. H. Searle, entitled "Quantity Taking."

ENGINEERING.

FRIDAY, FEBRUARY 4, 1887.

THE DEPRESSION OF TRADE.

IN our issue of the week before last we dealt with some of the characteristic features in the report of the recent Royal Commission on Trade Depression. We now propose to review the conclusions arrived at by the commissioners and the deductions to be drawn from them. Those who subscribed to the majority report, to which we will first refer, "are satisfied that in recent years, and more particularly in the years during which the depression of trade has prevailed, the production of commodities generally, and the accumulation of capital in this country, has been proceeding at a rate more rapid than the increase of population." In conjunction with this we must remember that the evidence shows that the producers, more especially the employers of labour, have had to be content with smaller profits, excepting in the very large number of cases in which there have been no profits at all, or even actual losses in manufacturing and selling. In some cases, as is well known, these losses have been considerable, but manufacturers have often faced them in order to keep their men together and their plant from rusting. As a corollary from these conditions it follows that manufactured goods have, on the whole, been lower in price, and it is equally evident also that persons with fixed incomes have been the gainers. The number of such persons is, however, but small, for there are few, outside the servants of the Crown and State, who do not derive some income from undertakings influenced more or less directly by the commerce of the nation. We think it unnecessary, however, for us to discuss the problem as it affects non-workers and the professional classes, and we confine our attention to the two great commercial parties, the employer of labour and the workman: referring to the position of the dealer, or "middle man," so far only as it affects these two classes. It is from employers that the Commission found complaints chiefly proceeded, and there can be no doubt, to any one who reads the evidence dispassionately, that the capitalist and employer of labour has within late years received less and less reward for the enterprise, forethought, and anxiety necessary to the successful conduct of manufacturing establishments. This may be perhaps contrary to generally received opinion, and there are, doubtless, many exceptions to the rule; but these exceptions are far more rare than would at first appear. It is easy to point to the success of some commercial magnate, who has, by his exceptional industry and capacity, wrested wealth even from the griping times of depression, but such a man represents one in thousands, and stands out the more conspicuously by his isolation from his fellows. For example, the three booming years of shipbuilding activity, when prices reached their highest pitch, were doubtless halcyon days for some owners of shipyards and engineering shops, but it would surprise many, could the actual figures be known, to find how infinitely small was the share of enhanced profits that fell to the employers' lot compared to that which was shared by the men.

The report considers the position of artisans and labourers from two points of view, firstly, "whether the reduction of profits, which has told on so many of the employers, has prejudicially affected the employed by causing a scarcity of employment;" and secondly, "whether reductions have been made in their wages, and, if so, whether such reductions have been compensated by the low prices of commodities, or by the shortening of their hours of work." These two questions are not satisfactorily disposed of in the report, a fact at which no surprise should be expressed.

There is what is called "a broader view of the question," which the Commission takes into its consideration. Whether "the aggregate quantity of commodities produced is on the increase and is growing at a more rapid rate than the population?" If this question can be answered in the affirmative, then, the report says, the depression in particular industries or among particular classes of producers cannot be regarded as an indication of corresponding national loss. The case is not very definitely, or rather very closely stated, but even as put, it will doubtless not meet with a very wide measure of assent, for though depression in some industries may be balanced, so far as total returns go, by growth in others, the depressed industries may be far more profitable, and nationally far more important tham those increased.

The "broader question" thus put the majority report answers in the affirmative. "We are satisfied," it says, "that in recent years, and more particularly in the years during which the depression of trade has prevailed, the production of commodities generally and the accumulation of capital in this country has been proceeding at a more rapid rate than the increase of population." In support of the view that our material prosperity is increasing, the statistics of pauperism, education, crime, savings banks, &c., are referred to. To what extent the figures under these heads may be taken as conclusive evidence of the stable prosperity of the nation need not be discussed just at present, but one or two elementary considerations will at once occur. For instance, pauperism may be checked, as is elsewhere pointed out, by increased watchfulness and severity in administering relief. Many forms of crime are the direct consequence of increased spending power amongst some classes, and savings banks represent an amount of capital for which more profitable uses cannot be found; whilst education has been compulsory, and it cannot therefore be taken as a proof of increased prosperity, although it may be a gain to the country. No doubt these views represent the despondent side of the question, but they should be given due weight in an Inquiry on the Depression of Trade.

The statistics of the internal trade of the kingdom are, as the report states, "very imperfect," but the information obtained from foreign trade returns, and by statistics relating to raw material, is considered by the report to point to the conclusion that our production is in advance of the rate of increase of our population, and the "apparent falling-off in some respects" is attributed entirely to the fall in prices, more particularly of raw materials, since 1873. The report next quotes some figures of Mr. Giffen in which the actual value of exports and imports for three years are reduced to a common rate of value, *i.e.*, that ruling in 1873. They are as follows:

Imports.

Year.	Declared Values. Millions Sterling.	Values Computed at the Prices of 1873. Millions Sterling.
1873	371	371
1879	363	438
1883	427	512
	Exports.	
1873	255	255
1879	191¼	273
1883	240	349

These figures are interesting, but unless we grant that volume of trade in commodities is equal to prosperity of trade, they fail to establish the position the report would claim. The commissioners appear to have had an idea that such a question might be raised, for in a previous paragraph, it is stated that "a fall of prices may involve a reduction of profits to those immediately engaged in producing or dealing in the commodities affected; but it is not necessarily injurious to the community at large;" a conditional mode of putting the case which admits the possibility of the alternative proposition.

But even if we adopt the report's interpretation of the figures there is a serious objection to them, inasmuch as they omit the three most important years in the series, viz., those of 1884, 1885, and 1886. Of course the report was framed before the latter year was concluded, and it is fair to state

that the absence of figures for '84 and '85 is pointed out, and an acknowledgment made that their inclusion "would doubtless necessitate some modification of the figures."

It is sometimes claimed that the prosperity of a nation may be better gauged by its imports than by its exports, and although there is some plausibility in the argument—for if the country does not possess money it cannot buy, and it matters little how money comes so that the supply does not fail—yet it is of far too general a nature to admit of universal application. A nation, like an individual, may be purchasing by capital as well as by income, and in such a case increased imports are a decided source of weakness. It is true an endeavour is made to show that this is not the case with Great Britain in the present day, but the foundation upon which the argument is built is by no means beyond question.

Some statements made by Mr. G. Auldjo Jamieson, in the remarks by which he qualified his assent to the report, will illustrate this.

In the first place Mr. Jamieson thinks that due prominence is not given in the report to the "emphatic expression and wide concensus of opinion," that the disturbance of the relations of the precious metals to each other—*i.e.* the diminished supply of gold and increased supply of silver—exercises an important, some say a paramount influence on the depression. This is a question that stands out from the rest of the problem, and an adequate discussion of it would have swollen the inquiry even beyond the perhaps overgrown dimensions it has already attained. Mr. Jamieson next criticises the figures as to imports and exports above quoted. Estimating the imports and exports for 1883 at the values of 1873 we find an increase during the intervening ten years of 235 millions sterling. This is made up by 141 millions of imports and 94 millions of exports. To this 141 millions increase of imports, the products of agriculture and sugar contribute about 57 millions as follows:

	1873.	1883.
Animals and meat	11,254	20,232
Butter	6,955	12,090
Cheese	4,061	5,381
Corn	51,672	84,108
Sugar	21,160	30,142
	95,002	151,933

The above figures Mr. Jamieson considers of importance, "because, while the whole volume of the imports of 1873, amounting to 371 millions, are dealt with in the report, the actual adjustment of prices is made by Mr. Giffen with respect to only 308 millions."

The increased imports of food products as shown above either represent an amount we have not the facilities to produce in this country or a lying dormant of our natural resources, and on this question Mr. Jamieson quotes some interesting figures. Compared with the period of 1871-75, the average in the United Kingdom under crop in 1883 with wheat, barley, rye, beans, peas, mangold, potatoes, &c., showed a decrease represented by a value of products amounting to 14,891,800*l.* The average of oats and grass, however, represented an increase of 1,629,250*l.*, the net decrease under these two heads being therefore 13,262,551*l.* The falling off in the number of sheep was valued at 8,478,750*l.*, but an increase in horses, cattle, and pigs of 5,211,000*l.* leaves a decrease under both heads of 3,267,750*l.*, so that the net diminution under all heads was 16,530,000*l.* This total is quite insufficient to account for the increase in food imports, which, between 1873 and 1883, was 47,869,000*l.*, and in order to account for the discrepancy we must include in our calculation not only the acreage not under crop, but the decreased value of food materials actually produced. This Mr. Jamieson calculates to amount to 30,068,000*l.*, so that on the whole the loss to the agriculturist and farmer has been 48,181,000*l.* This is not very far from balancing the increased amount of food products imported.

We, in England, have long been taught to consider it our destiny to become less and less a food-producing community, but rather a nation of manufacturers, working up raw material into finished products. So long as the profits on trading and manufacturing are sufficient to purchase the necessaries of life, and the wealth of the country is fairly distributed, that is all we want. Our money in foreign markets will always purchase the food which can be grown at better advantage elsewhere. Whether this balance between decreased natural production and increased profit on trading and manufacturing was being maintained it was the duty of the Commission as far as possible to decide. We have quoted Mr. Jamieson's figures on one side of the question; it will be necessary now to take the other side of the case.

Turning to the majority report again we find it stated that "the production of coal and pig iron and the consumption of raw cotton and imported wool have largely increased in the five years 1880-84; and that this increase has been greater than the increase of population." The figures are important, so we will quote them:

Period.	Coal.		Pig Iron.		Raw Cotton.		Raw Wool.	
	Average Quantity Raised.	Per Head of Population.	Average Quantity Produced.	Per Head of Population.	Net Imports (Annual Average).	Per Head of Population.	Net Imports (Annual Average).	Per Head of Population.
	mill. tons	tons	mill. tons	tons	mill. cwt.	lb.	million lb.	lb.
1865-69	103	3.29	4.1	.14	8.1	29.8	144.0	4.0
1870-74	120	3.79	4.9	.16	11.2	39 3	180.5	5.6
1875-79	133	3.97	6.4	.19	11.0	36.6	197.4	5.8
1880-84	156	4.43	8.1	.23	13.2	41.8	217.1	6.1

The report also gives a Table showing the growth of the goods traffic on railways. We have not space to reproduce these figures, but it may be stated broadly, so far as they go, that they tend to support the Table last quoted.

These are reassuring facts, but it must not be forgotten that "volume of trade" and "prosperity" are not necessarily synonymous terms. The workshops and factories of the country must be kept going, and it is better for a manufacturer to work at no profit, or even at a loss, for a while, in hope of better times, than to shut up shop. This, however, cannot last for long, and capital unremunerative in England will soon find more profitable channels. Examples of this have already been seen, although not to a sufficient extent as yet to seriously affect the great volume of trade. On the other hand, it is difficult to imagine that the trade in the four materials named—coal, iron, cotton, and wool—would have gone on increasing in the surprising manner it has unless there had been the stimulus of profitable returns.

The fact of "volume of trade" not always representing "value of trade" is recognised in the report. "So far as we are able to judge," it says, "there is a general agreement that business is carried on with the smallest possible margin of profit, and in very many cases with no profit at all." Some of the conditional signatories of the report remark on this point. Messrs. Booth, Cohen, Gibbs, Jamieson, and Palgrave say, "It appears to us that it is profitable industry which is the source of wealth, and that if, as the evidence shows, much of the industry of the country is now carried on at a minimum of profit, and much at an absolute loss, the stimulus of profit being removed, production must ultimately diminish and reproductive wealth cease to be created." Mr. Jamieson, speaking for himself, only asks whether it is possible to find in the figures relating to the increased exports of coal and iron any evidence of real prosperity. "It is notorious," he says, "that coal and iron have of late yielded no adequate return on the capital engaged in these industries, and only a meagre recompense for the labour employed." The figures he quotes as to reduced prices, in support of this case, will doubtless be more or less familiar to the majority of our readers. "If," continues Mr. Jamieson, "the price obtained for coal just meets the cost of raising and selling, nothing remains to defray the capital employed; that capital is lost, or it remains an enhanced burden to be defrayed by an increased charge on coal to be hereafter raised." We do not quite agree with Mr. Jamieson's statement of the case, but the moral he draws is obvious. "I am satisfied," he says, "that the increment in the volume of the exports of coal and iron, which is the most notable compensation for the increment of the imports of foreign food, affords no compensation in its profitable results for the great loss sustained by the agriculture of the country. On a proper balance the depreciation of machinery and the great fall in the value of the capital engaged in these trades in the period between 1873 and 1883 will sweep away all the apparent profit with which they can be credited."

But we cannot, even if we put all these considerations on one side and take volume and value as always going hand in hand—we cannot even then dismiss all care from our minds. Mr. C. M. Palmer, in his qualifying remarks, reminds us that the production of pig iron has fallen yearly since 1882 up to 1885, a fact not disclosed by the statistics of the Board of Trade adopted in the report. In 1882 the make was nearly eight and a half million tons; in 1885 it had fallen to seven and a quarter million tons. In the mean time the proportion of iron smelted from foreign ores has increased.

The production of manufactured iron and of Bessemer steel has also decreased since 1882, and of coal since 1883. The serious falling off in shipbuilding of late will account for much of this, a result which is not due to outside competition, but simply to reckless over-production within the limits of the United Kingdom.

The income tax returns, which have shown a steady increase, are quoted at some length in the report by way of supporting the contention that our national wealth is not on the wane. It would be foolish to ignore this favourable evidence, but at the same time there are points not to be overlooked. Between 1874 and 1885 the increase in the number of persons assessed was at the rate of 29.84 per cent. This average is made up chiefly by the increase in incomes between 200*l.* and 1000*l.*, which show an advance for the period named of 32.35 per cent. Between 1000*l.* and 2000*l.* the advance is 12.21 per cent., between 2000*l.* and 3000*l.*, 6.34 per cent.; between 3000*l.* and 4000*l.*, 3.07 per cent.; and between 4000*l.* and 5000*l.*, 7.07 per cent. On the other hand, incomes between 5000*l.* and 10,000*l.* had decreased 5.25 per cent., whilst over 10,000*l.* the falling off had been 4.91 per cent. The figures are curious, but if they may be taken as a true gauge of additional wealth, are very reassuring. That the earning power of "the classes" should have increased at all is satisfactory, but that the number of people fairly well to do should be multiplying so rapidly, rather than that wealth should be passing into fewer hands, is still more satisfactory. This method of reading the evidence of the income tax by the numbers of incomes assessed, giving a wide range to each estimate, such as from 200*l.* to 1000*l.*, can only afford an approximate idea of the actual state of affairs. Mr. Jamieson attempts to arrive at a truer result by taking the total amounts of incomes assessed. Allowing for the growth in population we find the increase in the amount of incomes assessed for the ten years 1845-55 was 16.8 per cent.; from 1855 to 1865 it was 18.9 per cent.; for 1865-75, 32.6 per cent.; and for the ten years ending 1885, 2.3 per cent. These examples, considered against those before quoted, tend to show how easy it is to prove anything by figures.

Amongst other influences to which the depression in trade is attributed are the unwonted expansion of industrial enterprise caused by the Franco-German war, and the influences of the Limited Liability Acts. The class of professional company "promoters" comes in for a full, and in one sense perhaps an undeserved, share of the Commissioners' censure. We certainly have never looked on these gentlemen as the agents of over-production of any commodity, unless it may be of a commodity of bad language. No doubt "companies" will often go on producing fully long after a private firm would have contracted its operations, for managers like to show a big return of business done, even if there be little or no profit, but this is not the fault of promoters of the class referred to. The Commissioners in the main and subsidiary reports make several recommendations under this head, but they would do little even if they could be carried out to remedy existing depression. The "middleman" is also by no means a favourite with the Commissioners, and indeed, in the abstract, with few other people. The report considers that the stocks thrown on the markets by dealers have done much to prevent the return of manufacturing industry. This may be true, but if the functions of the dealer were properly carried out he would act as a flywheel to trade, buying all he could when stocks were cheap and selling when they were dear. But if the class of dealers were far more numerous than at present they could not have carried us over the present depression; any more than a flywheel could keep an engine going after fires were let out and the boiler had become cold. However much the middleman may be abused, civilisation will never get rid of him. Legitimate dealers are necessary to trade; it is weak speculators that are its curse.

The great problem of foreign duties and bounties is treated of by the whole Commission either individually or collectively, and this leads to the burning question of Fair Trade. It would be useless at the end of an article, such as this, to attempt to review the opinions set forth on this momentous question, but on one point all appear to be agreed; that to the protective duties of foreign countries much of the present distress is to be attributed.

A study of the evidence given before the Commissioners, and their report, has led to the conclusion in our mind, that neither at the door of the employers nor of the workmen can the blame for the present depression be exclusively laid. It would seem that the British manufacturer is often too stiff-necked. He will not conform to the wants of his customers or learn their requirements, but will know best what is good for them. It is a relic of the good old times when our merchants and manufacturers had a monopoly of so many branches of the world's commerce, and could say "take it or leave it" with impunity; sure that their customers must accept the former alternative. Those times are gone for ever, and, unless we learn to treat purchasers with greater consideration, the more supple foreigner will quickly gain our markets. The point may not seem an important one, but it is having a marked influence on the export trade of the country. Even English merchants are driven abroad to get their wants supplied, because English manufacturers disdain to study their convenience. The case against the men is perhaps more serious, and certainly is more unpleasant to express. In good times high wages are earned — and spent. It would seem that no excess of payment over ordinary rates would enable British workmen, considering them in the gross, to save. Perhaps the most striking example that could be gathered from the whole history of commercial enterprise, might be furnished by the boom in the shipbuilding trade of three years ago. Then men were earning what would have been previously considered fabulous wages—four five, or six times as much as they are now forced to support themselves upon. How that money was spent is best known to those who were engaged in shipbuilding centres at the time; and how little was saved was proved by the quickness with which the cry of distress was heard as soon as work ceased. Had the vast surplus of earnings been saved by the toilers, and judiciously invested where it would have been available when the pinch came, the trade of the country would never have sunk to the low ebb it has since reached. After all, the working classes are the great consumers of produce, and it is they who chiefly keep the ball of commerce rolling, not only by production but by consumption. Some time ago we were horrified in England by accounts from abroad of corn being used for fuel, whilst thousands of our fellow-countrymen, and, still more, countrywomen and children, had only food enough to keep body and soul together. The rates of freight were low enough, indeed ships were laid up in nearly every dock in the kingdom, yet English working men had not money enough to pay that low freight to bring to their own mouths the corn that was being burnt. A little self-denial in the busy times, a little saving from their days of abundance, would have kept thousands of tons of shipping on the seas to supply full meals in place of the bare crust that now, too often, stands only between the unemployed and starvation or the poorhouse.

THE WEATHER OF JANUARY, 1887.

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The distribution of rainfall in amount and frequency is roughly represented by the following results:

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THE WELSBACH INCANDESCENT GAS BURNER.

THE production of light for illuminating purposes by the incandescence of a refractory material, has been the cherished object of many inventors, some of whom have so far developed their ideas as to have brought them more or less successfully from the laboratory into the market. The Clamond, Popp, Lewis,* and more recently the Lowe and the Auer von Welsbach systems, are those of which we have heard the most, and which have found a more or less extended practical application. This last-named has been for a considerable time tested on a large scale in Vienna, and is now being somewhat tardily brought to the notice of the public in this country. Before Auer von Welsbach, a Viennese scientist, discovered the way to utilise one of the most refractory of known materials —zirconia—highly resistant earths and metals had been employed. Thus the Clamond system comprises the use of magnesia either in filaments, slabs, or pencils, against which the intense heat produced by a modified Bunsen burner is projected. Popp, Lewis, and Lowe, on the other hand, employ a cage of platinum, but in each of the two typical systems, gas and air have to be supplied to the burner at exceptional pressures, involving special arrangements which complicate the process, and limit the range of their applications. With water gas such special arrangements are unnecessary, and we believe that at many factories in Germany, where water gas is made use of, the Clamond system, is found to give satisfactory results. The pencils of magnesia, however, require very frequent renewal, and although the cost thus incurred is insignificant, the comparatively short duration of the incandescent material presents a grave difficulty. In those systems, also, where cages of platinum wire are employed, the same objection applies with greater force, for not only does the platinum soften and absorb carbon under the continued action of intense heat, but the colour of the light is not good, and the cost of renewal is relatively heavy.

The system of Professor Auer is one of extreme beauty and ingenuity. He extracts by a complicated chemical process the metal zirconia from one or other of the several zircon ores found in nature, and combines it in solution with solutions of lanthanum, and of one or more other rare and refractory metals, to obtain the basis on which his incandescent light depends. With the fluid thus produced he impregnates a hood of finely woven fabric, which, when dry, is suspended over a Bunsen burner and ignited; the combustible fabric is burnt away, the water of the solution evaporated, and there remains a delicate, an extremely delicate, zirconian counterpart of the original fabric, shrunk, of course, but perfect in every mesh. Prior to impregnation the top of the hood is secured by a fine platinum wire, which subsequently serves as a means of support, it being attached to a stem placed in the fittings of the lamp. The burner employed is of the Bunsen type, modified by an old and well-known device, so that it can be turned down without "lighting back," and the heat thus obtained, without any augmentation of pressure, is sufficient to bring the zirconia skeleton to a state of brilliant white incandescence, the luminous energy of the gas consumed in this way being considerably higher than when burnt in the most economical gas burner. As much as seven or eight candles per foot of gas burnt per hour can be obtained, though probably this is considerably higher than the average that would be given. There being no flame, the light is absolutely steady.

An installation of Welsbach burners has been erected at the Marlborough Gallery of Paintings, 53, Pall Mall, S.W., and awakens the admiration of all who see it, both for the absolute steadiness of the light and for the beautiful quality of the illumination, which has a tone intermediate between that of an electric incandescence and an arc lamp. All the shades of green and blue in the paintings hung on the walls of the gallery come out with perfect accuracy, and it only needs the substitution of another source of light to render evident the great difference between gas burned under the Welsbach system and any other in vogue in this country. Fifty-six burners are arranged in two rows along the centre of the room, and provide an illumination which is perfectly steady and noiseless, free from all dirt and smoke, and far less heating than usual, since little more than only one-third the ordinary quantity of gas per unit of light is consumed.

The burners at the Marlborough Gallery are, we believe, of Austrian manufacture, but their production in this country is being attempted. Those we are describing are formed of a Bunsen burner having a gas jet on the principle of the watering rose, that is with a number of small holes through which the gas is emitted in fine streams which mingle with air entering the mixing tube at the sides, in the usual manner. This arrangement gives a short flame of great heat, and one which is quite free from all hissing sound. The gas burns at the outlet of the mixing tube, within a hood or mantle formed of zirconia, as already described. This hood is made originally from hoisery fabric in the form of a tube, and is supported by a ring of platinum wire at its upper end. The tube is first doubled on itself, and then the wire is sewn into it, thus securing the hem, and forming a means of attachment. By the aid of two extensions, the wire ring thus formed is secured to a support, and the hood is held over the flame. According to another method of manufacture devised by Mr. A. Paget, of Loughborough, the hoods are each made separately on a hosiery frame, and are provided with a channel, such as ladies call a string-case, at the upper edge. The platinum wire is threaded through this channel, and is provided with a cross-loop, like a bucket handle, by which the hood can be suspended from a hook. This arrangement gives a neat appearance to the hood, and causes the shrinkage to take place in a more symmetrical manner, avoiding plaits which may ultimately become sources of weakness owing to unequal temperature.

As the hood, after its incineration, is extremely fragile, it is necessary that it shall be protected as far as possible from the dangers of transport and handling. For [illegible]

that the absence of figures for '84 and '85 is pointed out, and an acknowledgment made that their inclusion "would doubtless necessitate some modification of the figures."

It is sometimes claimed that the prosperity of a nation may be better gauged by its imports than by its exports, and although there is some plausibility in the argument—for if the country does not possess money it cannot buy, and it matters little how money comes so that the supply does not fail—yet it is of far too general a nature to admit of universal application. A nation, like an individual, may be purchasing by capital as well as by income, and in such a case increased imports are a decided source of weakness. It is true an endeavour is made to show that this is not the case with Great Britain in the present day, but the foundation upon which the argument is built is by no means beyond question.

Some statements made by Mr. G. Auldjo Jamieson, in the remarks by which he qualified his assent to the report, will illustrate this.

In the first place Mr. Jamieson thinks that due prominence is not given in the report to the "emphatic expression and wide concensus of opinion," that the disturbance of the relations of the precious metals to each other—*i.e.* the diminished supply of gold and increased supply of silver—exercises an important, some say a paramount influence on the depression. This is a question that stands out from the rest of the problem, and an adequate discussion of it would have swollen the inquiry even beyond the perhaps overgrown dimensions it has already attained. Mr. Jamieson next criticises the figures as to imports and exports above quoted. Estimating the imports and exports for 1883 at the values of 1873 we find an increase during the intervening ten years of 235 millions sterling. This is made up by 141 millions of imports and 94 millions of exports. To this 141 millions increase of imports, the products of agriculture and sugar contribute about 57 millions as follows:

	1873.	1883.
Animals and meat	11,254	20,232
Butter	6,955	12,090
Cheese	4,061	5,381
Corn	51,672	84,108
Sugar	21,160	30,142
	95,002	151,933

The above figures Mr. Jamieson considers of importance, "because, while the whole volume of the imports of 1873, amounting to 371 millions, are dealt with in the report, the actual adjustment of prices is made by Mr. Giffen with respect to only 308 millions."

The increased imports of food products as shown above either represent an amount we have not the facilities to produce in this country or a lying dormant of our natural resources, and on this question Mr. Jamieson quotes some interesting figures. Compared with the period of 1871-75, the average in the United Kingdom under crop in 1883 with wheat, barley, rye, beans, peas, mangold, potatoes, &c., showed a decrease represented by a value of products amounting to 14,891,800*l.* The average of oats and grass, however, represented an increase of 1,629,250*l.*, the net decrease under these two heads being therefore 13,262,551*l.* The falling off in the number of sheep was valued at 8,478,750*l.*, but an increase in horses, cattle, and pigs of 5,211,000*l.* leaves a decrease under both heads of 3,267,750*l.*, so that the net diminution under all heads was 16,530,000*l.* This total is quite insufficient to account for the increase in food imports, which, between 1873 and 1883, was 47,869,000*l.*, and in order to account for the discrepancy we must include in our calculation not only the acreage not under crop, but the decreased value of food materials actually produced. This Mr. Jamieson calculates to amount to 30,068,000*l.*, so that on the whole the loss to the agriculturist and farmer has been 48,181,000*l.* This is not very far from balancing the increased amount of food products imported.

We, in England, have long been taught to consider it our destiny to become less and less a food-producing community, but rather a nation of manufacturers, working up raw material into finished products. So long as the profits on trading and manufacturing are sufficient to purchase the necessaries of life, and the wealth of the country is fairly distributed, that is all we want. Our money in foreign markets will always purchase the food which can be grown at better advantage elsewhere. Whether this balance between decreased natural production and increased profit on trading and manufacturing was being maintained it was the duty of the Commission as far as possible to decide. We have quoted Mr. Jamieson's figures on one side of the question; it will be necessary now to take the other side of the case.

Turning to the majority report again we find it stated that "the production of coal and pig iron and the consumption of raw cotton and imported wool have largely increased in the five years 1880-84; and that this increase has been greater than the increase of population." The figures are important, so we will quote them:

Period.	Coal.		Pig Iron.		Raw Cotton.		Raw Wool.	
	Average Quantity Raised.	Per Head of Population.	Average Quantity Produced.	Per Head of Population.	Net Imports (Annual Average).	Per Head of Population.	Net Imports (Annual Average).	Per Head of Population.
	mill. tons	tons	mill. tons	tons	mill. cwt.	lb.	million lb.	lb.
1865-69	103	3.29	4.1	.14	8 1	29.8	144.0	4.0
1870-74	120	3.79	4.9	.16	11.2	39 3	180.5	5.6
1875-79	133	3.97	6.4	.19	11 0	36.6	197.4	5.8
1880-84	156	4.43	8.1	.23	13.2	41.8	217.1	6.1

The report also gives a Table showing the growth of the goods traffic on railways. We have not space to reproduce these figures, but it may be stated broadly, so far as they go, that they tend to support the Table last quoted.

These are reassuring facts, but it must not be forgotten that "volume of trade" and "prosperity" are not necessarily synonymous terms. The workshops and factories of the country must be kept going, and it is better for a manufacturer to work at no profit, or even at a loss, for a while, in hope of better times, than to shut up shop. This, however, cannot last for long, and capital unremunerative in England will soon find more profitable channels. Examples of this have already been seen, although not to a sufficient extent as yet to seriously affect the great volume of trade. On the other hand, it is difficult to imagine that the trade in the four materials named—coal, iron, cotton, and wool—would have gone on increasing in the surprising manner it has unless there had been the stimulus of profitable returns.

The fact of "volume of trade" not always representing "value of trade" is recognised in the report. "So far as we are able to judge," it says, "there is a general agreement that business is carried on with the smallest possible margin of profit, and in very many cases with no profit at all." Some of the conditional signatories of the report remark on this point. Messrs. Booth, Cohen, Gibbs, Jamieson, and Palgrave say, "It appears to us that it is profitable industry which is the source of wealth, and that if, as the evidence shows, much of the industry of the country is now carried on at a minimum of profit, and much at an absolute loss, the stimulus of profit being removed, production must ultimately diminish and reproductive wealth cease to be created." Mr. Jamieson, speaking for himself, only asks whether it is possible to find in the figures relating to the increased exports of coal and iron any evidence of real prosperity. "It is notorious," he says, "that coal and iron have of late yielded no adequate return on the capital engaged in these industries, and only a meagre recompense for the labour employed." The figures he quotes as to reduced prices, in support of this case, will doubtless be more or less familiar to the majority of our readers. "If," continues Mr. Jamieson, "the price obtained for coal just meets the cost of raising and selling, nothing remains to defray the capital employed; that capital is lost, or it remains an enhanced burden to be defrayed by an increased charge on coal to be hereafter raised." We do not quite agree with Mr. Jamieson's statement of the case, but the moral he draws is obvious. "I am satisfied," he says, "that the increment in the volume of the exports of coal and iron, which is the most notable compensation for the increment of the imports of foreign food, affords no compensation in its profitable results for the great loss sustained by the agriculture of the country. On a proper balance the depreciation of machinery and the great fall in the value of the capital engaged in these trades in the period between 1873 and 1883 will sweep away all the apparent profit with which they can be credited."

But we cannot, even if we put all these considerations on one side and take volume and value as always going hand in hand—we cannot even then dismiss all care from our minds. Mr. C. M. Palmer, in his qualifying remarks, reminds us that the production of pig iron has fallen yearly since 1882 up to 1885, a fact not disclosed by the statistics of the Board of Trade adopted in the report. In 1882 the make was nearly eight and a half million tons; in 1885 it had fallen to seven and a quarter million tons. In the mean time the proportion of iron smelted from foreign ores has increased.

The production of manufactured iron and of Bessemer steel has also decreased since 1882, and of coal since 1883. The serious falling off in shipbuilding of late will account for much of this, a result which is not due to outside competition, but simply to reckless over-production within the limits of the United Kingdom.

The income tax returns, which have shown a steady increase, are quoted at some length in the report by way of supporting the contention that our national wealth is not on the wane. It would be foolish to ignore this favourable evidence, but at the same time there are points not to be overlooked. Between 1874 and 1885 the increase in the number of persons assessed was at the rate of 29.84 per cent. This average is made up chiefly by the increase in incomes between 200*l.* and 1000*l.*, which show an advance for the period named of 32.35 per cent. Between 1000*l.* and 2000*l.* the advance is 12.21 per cent., between 2000*l.* and 3000*l.*, 6.34 per cent.; between 3000*l.* and 4000*l.*, 3.07 per cent.; and between 4000*l.* and 5000*l.*, 7.07 per cent. On the other hand, incomes between 5000*l.* and 10,000*l.* had decreased 5.25 per cent., whilst over 10,000*l.* the falling off had been 4.91 per cent. The figures are curious, but if they may be taken as a true gauge of additional wealth, are very reassuring. That the earning power of "the classes" should have increased at all is satisfactory, but that the number of people fairly well to do should be multiplying so rapidly, rather than that wealth should be passing into fewer hands, is still more satisfactory. This method of reading the evidence of the income tax by the numbers of incomes assessed, giving a wide range to each estimate, such as from 200*l.* to 1000*l.*, can only afford an approximate idea of the actual state of affairs. Mr. Jamieson attempts to arrive at a truer result by taking the total amounts of incomes assessed. Allowing for the growth in population we find the increase in the amount of incomes assessed for the ten years 1845-55 was 16.8 per cent.; from 1855 to 1865 it was 18.9 per cent.; for 1865-75, 32.6 per cent.; and for the ten years ending 1885, 2.3 per cent. These examples, considered against those before quoted, tend to show how easy it is to prove anything by figures.

Amongst other influences to which the depression in trade is attributed are the unwonted expansion of industrial enterprise caused by the Franco-German war, and the influences of the Limited Liability Acts. The class of professional company "promoters" comes in for a full, and in one sense perhaps an undeserved, share of the Commissioners' censure. We certainly have never looked on these gentlemen as the agents of over-production of any commodity, unless it may be of a commodity of bad language. No doubt "companies" will often go on producing fully long after a private firm would have contracted its operations, for managers like to show a big return of business done, even if there be little or no profit, but this is not the fault of promoters of the class referred to. The Commissioners in the main and subsidiary reports make several recommendations under this head, but they would do little even if they could be carried out to remedy existing depression. The "middleman" is also by no means a favourite with the Commissioners, and indeed, in the abstract, with few other people. The report considers that the stocks thrown on the markets by dealers have done much to prevent the return of manufacturing industry. This may be true, but if the functions of the dealer were properly carried out he would act as a flywheel to trade, buying all he could when stocks were cheap and selling when they were dear. But if the class of dealers were far more numerous than at present they could not have carried us over the present depression; any more than a flywheel could keep an engine going after fires were let out and the boiler had become cold. However much the middleman may be abused, civilisation will never get rid of him. Legitimate dealers are necessary to trade; it is weak speculators that are its curse.

The great problem of foreign duties and bounties is treated of by the whole Commission either individually or collectively, and this leads to the burning question of Fair Trade. It would be useless at the end of an article, such as this, to attempt to review the opinions set forth on this momentous question, but on one point all appear to be agreed; that to the protective duties of foreign countries much of the present distress is to be attributed.

A study of the evidence given before the Commissioners, and their report, has led to the conclusion in our mind, that neither at the door of the employers nor of the workmen can the blame for the present depression be exclusively laid. It would seem that the British manufacturer is often too stiff-necked. He will not conform to the wants of his customers or learn their requirements, but will know best what is good for them. It is a relic of the good old times when our merchants and manufacturers had a monopoly of so many branches of the world's commerce, and could say "take it or leave it" with impunity; sure that their customers must accept the former alternative. Those times are gone for ever, and, unless we learn to treat purchasers with greater consideration, the more supple foreigner will quickly gain our markets. The point may not seem an important one, but it is having a marked influence on the export trade of the country. Even English merchants are driven abroad to get their wants supplied, because English manufacturers disdain to study their convenience. The case against the men is perhaps more serious, and certainly is more unpleasant to express. In good times high wages are earned — and spent. It would seem that no excess of payment over ordinary rates would enable British workmen, considering them in the gross, to save. Perhaps the most striking example that could be gathered from the whole history of commercial enterprise, might be furnished by the boom in the shipbuilding trade of three years ago. Then men were earning what would have been previously considered fabulous wages—four five, or six times as much as they are now forced to support themselves upon. How that money was spent is best known to those who were engaged in shipbuilding centres at the time; and how little was saved was proved by the quickness with which the cry of distress was heard as soon as work ceased. Had the vast surplus of earnings been saved by the toilers, and judiciously invested where it would have been available when the pinch came, the trade of the country would never have sunk to the low ebb it has since reached. After all, the working classes are the great consumers of produce, and it is they who chiefly keep the ball of commerce rolling, not only by production but by consumption. Some time ago we were horrified in England by accounts from abroad of corn being used for fuel, whilst thousands of our fellow-countrymen, and, still more, countrywomen and children, had only food enough to keep body and soul together. The rates of freight were low enough, indeed ships were laid up in nearly every dock in the kingdom, yet English working men had not money enough to pay that low freight to bring to their own mouths the corn that was being burnt. A little self-denial in the busy times, a little saving from their days of abundance, would have kept thousands of tons of shipping on the seas to supply full meals in place of the bare crust that now, too often, stands only between the unemployed and starvation or the poorhouse.

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THE production of light for illuminating purposes by the incandescence of a refractory material, has been the cherished object of many inventors, some of whom have so far developed their ideas as to have brought them more or less successfully from the laboratory into the market. The Clamond, Popp, Lewis,* and more recently the Lowe and the Auer von Welsbach systems, are those of which we have heard the most, and which have found a more or less extended practical application. This last-named has been for a considerable time tested on a large scale in Vienna, and is now being somewhat tardily brought to the notice of the public in this country. Before Auer von Welsbach, a Viennese scientist, discovered the way to utilise one of the most refractory of known materials—zirconia—highly resistant earths and metals had been employed. Thus the Clamond system comprises the use of magnesia either in filaments, slabs, or pencils, against which the intense heat produced by a modified Bunsen burner is projected. Popp, Lewis, and Lowe, on the other hand, employ a cage of platinum, but in each of the two typical systems, gas and air have to be supplied to the burner at exceptional pressures, involving special arrangements which complicate the process, and limit the range of their applications. With water gas such special arrangements are unnecessary, and we believe that at many factories in Germany, where water gas is made use of, the Clamond system, is found to give satisfactory results. The pencils of magnesia, however, require very frequent renewal, and although the cost thus incurred is insignificant, the comparatively short duration of the incandescent material presents a grave difficulty. In those systems, also, where cages of platinum wire are employed, the same objection applies with greater force, for not only does the platinum soften and absorb carbon under the continued action of intense heat, but the colour of the light is not good, and the cost of renewal is relatively heavy.

* See vol. xxxiv., pages 43, 119, and 601.

The system of Professor Auer is one of extreme beauty and ingenuity. He extracts by a complicated chemical process the metal zirconia from one or other of the several zircon ores found in nature, and combines it in solution with solutions of lanthanum, and of one or more other rare and refractory metals, to obtain the basis on which his incandescent light depends. With the fluid thus produced he impregnates a hood of finely woven fabric, which, when dry, is suspended over a Bunsen burner and ignited; the combustible fabric is burnt away, the water of the solution evaporated, and there remains a delicate, an extremely delicate, zirconian counterpart of the original fabric, shrunk, of course, but perfect in every mesh. Prior to impregnation the top of the hood is secured by a fine platinum wire, which subsequently serves as a means of support, it being attached to a stem placed in the fittings of the lamp. The burner employed is of the Bunsen type, modified by an old and well-known device, so that it can be turned down without "lighting back," and the heat thus obtained, without any augmentation of pressure, is sufficient to bring the zirconia skeleton to a state of brilliant white incandescence, the luminous energy of the gas consumed in this way being considerably higher than when burnt in the most economical gas burner. As much as seven or eight candles per foot of gas burnt per hour can be obtained, though probably this is considerably higher than the average that would be given. There being no flame, the light is absolutely steady.

An installation of Welsbach burners has been erected at the Marlborough Gallery of Paintings, 53, Pall Mall, S.W., and awakens the admiration of all who see it, both for the absolute steadiness of the light and for the beautiful quality of the illumination, which has a tone intermediate between that of an electric incandescence and an arc lamp. All the shades of green and blue in the paintings hung on the walls of the gallery come out with perfect accuracy, and it only needs the substitution of another source of light to render evident the great difference between gas burned under the Welsbach system and any other in vogue in this country. Fifty-six burners are arranged in two rows along the centre of the room, and provide an illumination which is perfectly steady and noiseless, free from all dirt and smoke, and far less heating than usual, since little more than only one-third the ordinary quantity of gas per unit of light is consumed.

The burners at the Marlborough Gallery are, we believe, of Austrian manufacture, but their production in this country is being attempted. Those we are describing are formed of a Bunsen burner having a gas jet on the principle of the watering rose, that is with a number of small holes through which the gas is emitted in fine streams which mingle with air entering the mixing tube at the sides, in the usual manner. This arrangement gives a short flame of great heat, and one which is quite free from all hissing sound. The gas burns at the outlet of the mixing tube, within a hood or mantle formed of zirconia, as already described. This hood is made originally from hoisery fabric in the form of a tube, and is supported by a ring of platinum wire at its upper end. The tube is first doubled on itself, and then the wire is sewn into it, thus securing the hem, and forming a means of attachment. By the aid of two extensions, the wire ring thus formed is secured to a support, and the hood is held over the flame. According to another method of manufacture devised by Mr. A. Paget, of Loughborough, the hoods are each made separately on a hosiery frame, and are provided with a channel, such as ladies call a string-case, at the upper edge. The platinum wire is threaded through this channel, and is provided with a cross-loop, like a bucket handle, by which the hood can be suspended from a hook. This arrangement gives a neat appearance to the hood, and causes the shrinkage to take place in a more symmetrical manner, avoiding plaits which may ultimately become sources of weakness owing to unequal temperature.

As the hood, after its incineration, is extremely fragile, it is necessary that it shall be protected as far as possible from the dangers of transport and handling. For this purpose the attachment, from which it is suspended, is fixed to a gallery which forms

the base of the chimney, and the three constitute a compact piece which can be moved safely. The hood cannot be unintentionally removed from the inside of the chimney, and the presence of the glass insures that reasonable care will be exercised in handling, even by ignorant servants. In connection with the gallery, which slides over the mixing tube of the burner, there is a grid which fits on the tube and prevents the flame striking back when the gas supply is reduced.

Experiments made on Monday last showed that with a consumption of 2.4 cubic feet of gas, at a pressure of .9 in. to 1 in. of water, an illumination of 18 standard candles was obtained, or an efficiency of 7.5 candles per cubic foot of gas. It is needless to say that this is a most successful result, and that if considerations of economy of consumption were the sole elements in the relation of gas burners, the Welsbach light must supersede all others. The question of the durability of the hood has, however, to be taken into account. Considering the very delicate nature of this part, which must not be subjected to rough usage of any kind, it is probable that in ordinary use comparatively few will perish of old age, but will be destroyed by accident. Laboratory experiments, however, show a duration of 1000 hours, with but little reduction in the light-giving qualities, and we believe that 2000 hours have been reached without remarkable deterioration. It is evident that if limits like these could be approached as an average, the cost of renewals would be insignificant, and the trouble involved inappreciable. But it is not likely that in common use, where the delicate film is exposed to careless and ignorant handling, and to all the thousand and one shocks of every-day life and work, that great longevity will be reached, and the item of cost and trouble may then enter as important factors in the equation of real usefulness. On the other hand, there is a large margin in economised gas, 50 per cent. is not too high an estimate, and this saving will balance damaged hoods and tired patience to a large extent, while an absolutely pure and steady light, a reduction in proportion to that of the gas consumed, in vitiated atmospheres, are no small advantages.

We believe that the Auer von Welsbach system has an extended field of usefulness before it, and that it will grow rapidly in favour in places where sufficient gas is burned to render it worth while for some with a capacity beyond that of domestic servants, to take charge of the fittings, and until it is challenged by some robuster and equally efficient rival, which will defy the destructive finger of the British housemaid. The Welsbach system with an actually, not relatively, strong hood would be practically perfect; it is for those interested in the question to arrive at this desideratum, and unless they can do so they can scarcely hope to hold a monopoly in gaslighting by incandescence, which promises to be for a time, at least, the "light of the future."

KRUPP GUNS.

The United States consul at Crefeld seems to have been an irritating thorn in Mr. Krupp's side. How Consul Potter obtained his special information, which he published much to Mr. Krupp's annoyance, concerning the doings in the great works at Essen, usually so jealously guarded, may be left to conjecture, but the fact remains that in his consular report for 1883, Mr. Potter, in giving some highly interesting facts respecting the manufactures at Essen, drew a rather unfavourable comparison with regard to the cost of the Krupp guns. It appears that more recently Consul Potter drew attention to the difficulties attending the manufacture of the 120-ton guns destined for Italy, and stated that at least one of these colossal weapons had failed. Mr. Krupp has in consequence felt called upon to reply at length to the consul, although in so doing the point raised by Mr. Potter has been ingeniously avoided. Mr. Krupp's answer to the above statement is, in effect, to give the results obtained with those of the guns which have been actually accepted. The point, however, which it would be interesting to know, is whether Krupp did or did not withdraw, as stated, one of the 120-ton guns after delivery in Italy, on pretext of making further firing trials with it at his own ranges in Germany, and then subsequently proceed with the manufacture of a new gun.

With respect to the actual performances of the 120-ton breechloading guns which are set forth in Mr. Krupp's reply, it cannot be said that they develop an energy proportionate to their great weight; 14,000 metre tons is not a high result for such a weapon. If we compare the performance of one of the Elswick guns of about the same size, we have very different figures. The following Table furnishes a comparison between the Elswick and Essen guns:

—	Calibre.	Total Weight.	Length.				Weight.		Muzzle Velocity.	Energy.				Wrought-Iron Plate Perforated.
			Total.	Calibres.	Of Bore.	Calibres.	Charge.	Shot.		Total.	Per 1000 kg. Weight of Gun.	Per cm. of Circumference.	Per cm. Section Shot.	
	cm.	kg.	mm.		mm.		kg.	kg.	m.	mt.	mt.	mt.	mt.	cm.
Armstrong ..	41.27	111,760	13,208	32	12,383	30	408.2	816.5	675.4	18,953	169.6	146.7	14.17	104.1
Krupp ..	40	121,038	14,000	35	12,700	32	325	1050	530	15,033	124.2	119.6	11.96	91

The Armstrong gun, it will be seen, is 8 tons less weight and two calibres less in length of bore, yet its energy and penetrating power are greatly superior to those of the heavier and longer Krupp gun. The figures given above are taken from a recent table of Krupp guns, but it appears that the energy there assigned to the 40-cm. gun is greater than that which was obtained in actual firing with the Italian guns.

The 110½-ton gun made at Elswick for the Benbow has practically the same power as that referred to above, and is, therefore, fully 25 per cent. more powerful than the Krupp gun, which is 10 tons heavier. The penetration into wrought-iron plating given in the Table is calculated for the Elswick gun from the formula Krupp uses for his gun, but this formula gives a higher result than experience in England with the larger sizes of guns has shown to be obtainable. The figures, therefore, are only given for purposes of comparison.

Perhaps the best evidence of the superiority of the English gun is to be found in the greater efficiency, as shown by the energy per 1000 kilos. weight of gun, which is 124.2 mt. for the Krupp as against 169.6 mt. for the Armstrong gun, or over 33 per cent. greater return from the weight of material used.

It will be seen, therefore, that we have no reason to fear a comparison between our guns and those of the great German maker. The trial of the Benbow's gun will take place shortly and will no doubt amply confirm the superiority shown above.

COLONIAL INDUSTRIES.

In a recent article on this subject (Engineering, December 24 and 31, 1886, pages 647, 657), when pointing out the various obstacles in the way of the establishment of iron manufactures in our Australian colonies, we alluded to the difficulty arising out of the liability, in so small a community, of the workmen demanding higher wages, or going out on strike, whenever they found the employers in their power under the onus of long-standing contracts with the Government. This difficulty, it will be remembered, was sought to be met by the deputation at their interview with the Minister for Public Works, referred to in the article, by the statement that agreements had been entered into with various societies "giving every assurance that there would be no disturbance" during the currency of Government contracts. In reference to these agreements we expressed the opinion that when occasion suited the workmen to cease working, the agreements would be found powerless to prevent them. As it may interest our readers to learn the nature of the agreements on which the employers placed so much reliance, we give the following extract on the subject from a report in the columns of the *Sydney Morning Herald*, to hand since the article was written, of a meeting of the Sydney branch of the Amalgamated Society of Engineers. The report states: "The special business which engaged the attention of those present during the greater part of the evening, was in connection with a three years' agreement between the employers and employés in the trades analogous to that described in yesterday's issue in the ironmoulding trade. The circumstances leading up to this agreement were similar to those connected with the ironmoulders, and the objects sought by the agreement were stated to be that 'in the event of the employers tendering for any large contracts with the Government they would be enabled to do so without fear of any agitation on the part of the workmen.' The following is the text of the agreement:

"'Memorandum of agreement entered into this 15th day of September, 1886, between the Local District Committee of the Amalgamated Society of Engineers, Millwrights, &c., of the one part, and the Iron Trades' Employers' Association of the other part, whereby the said Committee agrees that during a period of three years, to be computed from the 13th day of July, 1886, the members of the said Society shall not agitate for any alteration of the present minimum rate of wages, hours of working, rates for overtime and holidays, or trade customs as at present existing, with any members of the said Association who shall have obtained Government or other contracts, and so long as the contracts so obtained shall be in progress. In consideration for which the said Association agrees to pay during the aforesaid period of three years, and so long as any contracts entered into during that time shall be in progress, the present minimum rate of wages, viz., 15d. (1s. 3d.) per hour, and pay overtime rates as follows: Double time for the first two hours, time and half for all time afterwards until starting new day; double time for working Sunday, Christmas Day, Good Friday, and the eight hours demonstration day. It is also mutually agreed that eight hours shall constitute a day's work; each day shall stand on its own merits. Individual members of the said Society shall not be debarred from asking for an increase on the aforesaid minimum rate; and further, it is distinctly understood and agreed that the members of the said Society shall not work on more favourable terms for employers who are not members of the said Association. This agreement being the outcome of a conference between employers and representatives of the various societies connected with the iron trade, on the subject of petitioning the Government to have all constructive ironwork manufactured in the colony, it is distinctly understood that in the event of the Government not giving a preference to the colonial manufacturers, but continuing to import such work from England and foreign countries, this agreement shall be considered null and void. No advantage shall be taken of any technicality or informality of expression in this agreement by any party thereto, but it shall be carried out in a free spirit and in its full integrity.'"

In reference to this curious document we cannot help remarking that an agreement which, while binding the employers hand and foot to a minimum rate of 1s. 3d. per hour, or 10s. per day of eight hours, with double rate for the first two hours of overtime, does not "debar" . . . "individual members of the said Society" . . "from asking for an increase on the aforesaid minimum rate" (and inferentially, of course, admits of their ceasing to work if their request be denied them) is about as worthless an instrument for the purpose intended as the paper on which it is written. But there is another point in respect of which it reserves a loophole for the workmen to enable them to defeat their employers. After stating that the agreement is the outcome of a conference for "petitioning the Government to have all constructive ironwork manufactured in the colony," it goes on to say: "It is distinctly understood that in the event of the Government not giving a preference to the colonial manufacturers, but continuing to import such work from England and foreign countries, this agreement shall be considered null and void." It is clear, therefore, that if the Colonial Government continues to import work from abroad, and does not have "*all* constructive ironwork manufactured in the colony," or, in other words, unless the Government binds itself down to a hard and fast protectionist policy, the workmen are free to treat the agreement as null and void. From the employers' point of view the agreement suggests to the mind the schoolboy's rejoiner, "Thank you for nothing," and one cannot help wondering how the employers could be so readily taken in by such a one-sided

agreement. If the other "forty-five documents" referred to by the chairman of the Employers' Association at the interview with the Minister for Public Works are as worthless for protecting the employers as the one before us, we were correct in referring to them as worthless indeed.

The fact of the minimum rate of wages being fixed in the agreement at 10s. per day of eight hours, entirely confirms what we said in the previous article as to the high rate of wages in the Australian colonies standing in the way of the establishment in their midst of manufacturing industries.

KNEADING MACHINERY.

THERE are few manual operations which modern research has not succeeded in performing by mechanical means, obtaining at the same time both better and more economical results. Hand kneading is one of those which routine appears to abandon with the most reluctance. And this, notwithstanding that there is no calling more toilsome or more unhealthy to the workman than that of a baker, required as he is to work at night in underground chambers shut off from the air, and exposed to continual changes of temperature. What is the reason that mechanical kneading machines take the place of the arms of the workman so slowly? Is it to be found in the material conditions of the work, or in chemical actions little understood? Whatever may be the cause, the first essay in mechanical kneading dates back nearly three-quarters of a century, and yet this method is still the exception to-day.

The kneader of Lambert, or Lambertine, invented in 1811, was simply a box in which the flour was placed, together with the yeast and the water, the whole being turned by a handle without any attention on the part of the operator. The invention of Fontaine, which had no greater success, consisted in placing in the box two iron beaters, which assisted in the mixing. These two apparatus were far from effecting the complex work performed by the working baker. It is not sufficient that the flour, the yeast, and the water shall be intimately mixed; it is also necessary that the dough should absorb air to render the bread light and easy to digest. In recent times many inventors have endeavoured to fulful these conditions. One of the best known appliances is the Boland machine. The apparatus consists of a vat of sheet iron, in the axis of which there works a helicoidal stirrer, which first makes the mixture, then spreads the dough into sheet, and finally stretches it and exposes it to the air. The tub is reversible. When the work is finished the vessel is upturned, and a few turns of the stirrer forces out the dough. The largest size of machine will effect the kneading in seven minutes, with a speed of 12 to 16 revolutions per minute.

In the Durvie kneader the stirrer is a double comb, mounted on an axis which rotates in the centre of a wooden box. The teeth are so arranged that one cuts the dough raised by its neighbour. The Deliry machine consists of a cast-iron circular tank or tray, like that of a mortar mill, mounted on a vertical spindle and driven through bevel gearing either by hand or power. In the tank there is a kneader in the form of a lyre which mixes and cuts the dough, and the helicoidal arms which inflate the dough. A scraper continually pushes back the dough and cleans the stirrer. A machine very similar to the above is made by Messrs. Boucheron and Mazières. The apparatus invented by Mr. Paul Pfleiderer, of London, is slightly different. The principal part consists of two palettes of different forms turning at relative speeds in two semi-cylindrical troughs opening into each other tangentially. This double trough is mounted upon a cast-iron frame and can be turned over to effect the removal of the contents. The machine is driven by open and crossed belts on a pulley formed of two loose parts separated by a disc, which is keyed to the shaft. By means of a nut and a handwheel on the shaft either of the pulleys can be pressed against the disc, and thus be converted into a fast pulley. Fig. 1 shows M. E. Denel's kneader with a double conical grinder designed particularly for pastry. The kneading machine of M. Asselin, which has been adopted by the Italian Government for the manufacture of the bread for the army, is formed of a basin rotating on its axis. This basin is hemispherical, and is constructed of wood, and above it there turns a stirrer in the form of a screw of large dimensions, the arms of which raise the dough to a height of 90 centimetres (35½ in.), and effect a very complete stirring of the mass. The aëration is likewise completely insured. All the parts of the mechanism are exterior to the kneader. The axis of the mixing screw is carried by two bearings supported on brackets, and it can, therefore, be lifted out of the vessel. With this apparatus two men can in 20 to 25 minutes mix 426 kilogrammes (939 lb.) of dough.

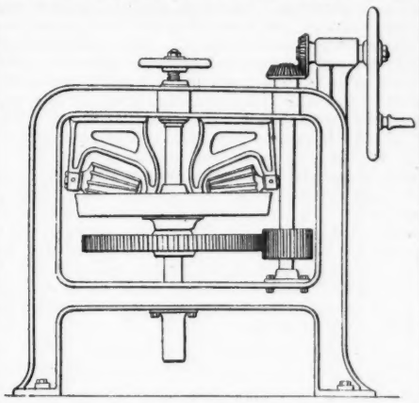


FIG. 1. DENEL'S DOUGH KNEADER.

The mixer of M. Purel (Fig. 2) is distinguished from the preceding by the following particulars: It consists of a wooden mixing trough A, similar to an ordinary trough, with arms carried by a slide on wheels, and thus movable on two rails. The mixing machine is fixed to the wall by the frame F. It has two blades C B, of which the one skims the edge of the mixer for its whole height, while the other, which turns the opposite way, stirs the interior. The hopper P, fixed to the framing, receives the flour from the floor above. It is furnished with a distributing cylinder operated by a handle. The division of the apparatus into three parts renders the clearing very easy.

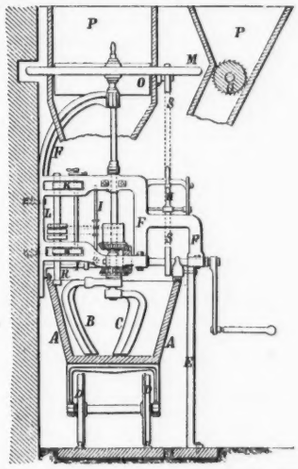


FIG. 2. PUREL'S FLOUR MIXER AND DOUGH KNEADER.

NOTES.

AN INTERNATIONAL EXHIBITION AT BRUSSELS.

ARRANGEMENTS are being made to hold an international industrial exhibition at Brussels in 1888. The site chosen is that of the 1880 Exhibition, and will include 40 acres of gardens, to be illuminated at night by the electric light, and to contain cafés and concerts, besides reproductions of famous ancient buildings. A wooden tower, 900 ft. high, is to be erected after the plans of MM. Hennebique and Néve, at an estimated cost of one-third that of the Eiffel iron tower projected for the Paris Exhibition of 1889. The cost is not expected to exceed 80,000*l.*, and M. Somzée, a wealthy engineer, is said to have offered half this sum to encourage other subscribers. The building of the tower will occupy 1000 workmen for the ensuing year. Its base will be pyramidal, and the spire above will be surrounded by three galleries, the lower of which, 3000 square feet in area, will be fitted up as a concert hall and kursaal.

PHOSPHORESCENT ALUMINA.

Mr. Crookes has communicated a paper to the Royal Society on a subject to which we have referred in recent Notes, namely, the phosphorescence of alumina *in vacuo*. In 1879 he showed that ruby (a form of alumina) glowed with a rich red in the electrical vacuum, whatever the natural colour of the stone. Recent experiments with a large spectroscope confirm his earlier observations. The spectrum of the light shows a faint and hazy pair of bands and a double crimson line characteristic of alumina. There are also a pair of fainter orange lines, then a dark space, and after that a continuous spectrum extending to the green. Whether the crimson line is really due to alumina or to impurities does not, however, seem as yet to be beyond all doubt.

THE SALE OF THE HOOSAC TUNNEL.

The State of Massachusetts has just consummated the rather peculiar transaction of the sale of a railway tunnel, which pierces the Hoosac range of mountains in the western portion of that State. This tunnel was projected in 1825 at an estimated cost of 1,948,557 dols., but its construction was begun by the State in 1851 and completed November 27, 1873, at a cost of 20,241,842 dols.; it has been sold to the Fitchburg Railroad Company for 10,000,000 dols. in stock and bonds of the company. The arch of the tunnel is 26 ft. wide and 22 ft. to 26 ft. high; much of it is lined with brick arching, 20,000,000 bricks being used for this purpose. The length of the tunnel is 25,081 ft. or 4¾ miles. There are two ventilating shafts which were originally sunk through the mountain for the purpose of providing four additional faces in the construction of the tunnel. Its situation being on a line of railroad, miles west of Boston, is of great importance in completing a direct railway line from Boston to the west.

DE BANG'S GUNS IN NORWAY.

A series of experimental trials with these guns have just been going on at Christiania before a special committee, and the results are so satisfactory that the important question, De Bang *versus* Krupp, has, no doubt, been definitely decided in favour of the former, as far as Norway is concerned. The guns have a calibre of 8.4 centimetres and the number of shots fired, amounting to 1000, have not effected the smallest trace of extension, the diameter measured before and after the 1000 shots agreeing to a hundredth part of a millimetre. The accuracy and the range of the firing have also been entirely satisfactory. Some minor drawbacks in connection with the gun-carriages and the regulating screws, both of which suffered somewhat from the powerful recoil, have been removed, and those now used have stood the last 600 rounds without the least hitch. De Bang's obturator packing—consisting of two-thirds asbestos and one-third sheep's tallow, covered with sailcloth—has also proved most effective, although quick series of thirty, forty, and even fifty shots have been fired without cleaning the barrel or other parts.

MANGANESE STEEL.

Professor W. F. Barrett has investigated the physical properties of manganese steel and given his results in a paper to the Royal Society of Dublin. Two wires of No. 19 S.W.G. gauge were drawn for him by the makers of this steel, Messrs. Hadfield and Co., of Sheffield. Their density was 7.808, and one was softened by sudden cooling; the other was kept hard. It is a peculiarity of this steel, which contains from 12 to 14 per cent. of manganese, that sudden cooling softens it, whereas slow cooling hardens it. No. 19 wire was found to have an electrical resistance of about 1 ohm per metre. The specific resistance in C.G.S. units was 77,000 for a cubic metre. Ordinary iron is only 9800. Mr. Barrett recommends it for electric light resistance coils. The steel is very slightly magnetic, its susceptibility to induced magnetism being only 300, as compared with 100,000 for iron, hence it is adapted for dynamos, bedplates, and ships' hulls. The tenacity of the hard wire was found to reach 110 tons per square inch, whereas the soft wire had a tenacity of only 48 tons per square inch. The modulus of elasticity was found to be lower than that of wrought iron, the mean number for the hard manganese wire being 16,800 kilogrammes per square millimetre, while the soft wire had a lower modulus. The modulus for ordinary steel wire is 18,810, and

for iron wire 18,610 kilogrammes per square millimetre.

Wood Pulp Industry in Norway.

The wood pulp industry in Norway for the year 1886 shows a very large increase upon the figures of a few years back, albeit prices have ruled very low. The cause for this is attributed not so much to overproduction as to excessive competition among the sellers of this article, and as a great many sales for forward delivery have been booked at extremely low prices (2*l.* 15s. f.o.b. Hull has in many cases been taken for wood pulp with 50 per cent. water), there are no immediate prospects of an improvement. The quantity exported during the year 1886 is about 120,000 tons; in the year 1885 it was 107,651 tons; 1884, 88,220 tons; 1883, 70,464 tons; 1882, 58,884 tons; 1881, 42,194 tons; 1880, 26,055 tons. Several of the old works have extended their production during the past year, and several new establishments are in the course of erection, so the production this year may probably be put at 150,000 tons wood pulp with 50 per cent. water. There have been four cellulose manufactories at work during the past year; two for the production of soda cellulose have worked with considerable success; two have produced sulphite cellulose; one of the latter has been burnt down. Nine more manufactories for sulphite cellulose are being built with a capacity of about 10,000 tons dry cellulose. The greater part of the Norwegian wood pulp is exported to England, France, and Belgium; in Russia the increase in the duty has stopped business, and the same can almost be said of Germany. America, too, has drawn part of her supply from Norway, but this trade is not expected to continue.

The Horse-Power of a Whale's Tail.

Sir William Turner, the eminent Professor of Anatomy in the University of Edinburgh, recently delivered a lecture to the members of the Philosophical Institution of that city on "Whales; their Structure and Habits," in the course of which he referred to a point of considerable interest to engineers, which was the horse-power exerted by the tail of a large whale. Regarding the length of full-grown whales, Professor Turner remarked that the porpoise was 4 ft. or 5 ft. long, whereas the Greenland right whale was from 50 ft. to 60 ft. long, and he said that the great finner-whale, which frequently visited the British seas, reached the length of 80 ft., or even more. An animal of the latter sort was stranded at Longniddry some years ago. After speaking at some length on the structure of whales, the lecturer made some remarks on the rate of speed at which they travelled. It had been estimated, he said, that the Greenland whale could attain a speed of nine or ten miles an hour, and that the finner-whales attained even a greater speed. In all probability the Longniddry whale could propel itself through the water at the rate of twelve miles an hour, and the sperm whale was said to be capable of driving itself along at the same rate of speed. He had asked Mr. John Henderson, of Glasgow, the well-known builder of the Anchor liners, to assist him in arriving at the horse-power which must be exercised by one of these great whales so as to acquire a speed of twelve miles an hour, and he put the case of the Longniddry whale before him. It was 80 ft. long, weighed about 74 tons, and had a tail 18 ft. to 20 ft. across from the extreme ends of its flanges. With these data Mr. Henderson calculated that a whale of the dimensions mentioned, in order to attain a speed of twelve miles an hour, would require to exercise a propelling force of 145 horse-power.

Trade Depression in Sweden.

One of the features most often referred to during the sitting of the late Lord Iddesleigh's Commission on Trade Depression, was the unfavourable influence of unequal or excessive railway rates. We are not alone in the world in having suffered from a protracted period of commercial stagnation, and it would seem that similar causes have produced like results in other countries. A despatch from Mr. E. Corbett, Her Majesty's minister at Stockholm, gives some particulars of the report of a Government Committee appointed to examine into the causes of and propose the best means for alleviating the existing distress, which had been felt in all industrial branches, more especially among farmers. The first subject taken up was the question of railway carriage, respecting which a separate report was issued. With the existing low price of all produce, the railway tariffs were found to press heavily on most of the staple products of the country, which are generally of a heavy nature, such as timber, ore, iron, coal, manure, and grain. The whole extent of railway lines in Sweden is 6894 kilometres. Of these 2387 kilometres are State railways, the remaining 4507 kilometres belonging to private companies. As the private lines do not seem disposed to lower their rates, the only practicable method to obtain that end is State purchase, and this the Committee strongly advises, provided reasonable terms can be made. Mr. Corbett thinks, however, that the general opinion of the country is adverse to the project, and a very influential member of the peasant party is strongly opposed to it. The people seem to fear a new loan, but Mr. Corbett is of opinion that such fear is to a great extent unfounded, as part of the purchase money would be provided by the annulling of the debt of the private railways to the Government, and doubtless the holders of railway bonds on debentures would be glad to exchange them for State bonds.

Locomotives for Australia.

It is announced in a recent number of the *Sydney Morning Herald* that specifications necessary for the invitation of tenders for the manufacture of locomotives required on the New South Wales railways were ready when the mail left Sydney, and that it was the intention of the Government to have tenders invited very shortly for a supply of locomotives. It is further stated that "the work will be tendered for by manufacturers outside the colony, as well as by manufacturers within it, but Mr. Lyne (Minister for Public Works) has stipulated that if the colonial tenderers can come within a certain distance of the tenders from manufacturers outside the colony, some consideration will be shown them." As Mr. Lyne was Minister for Works when the deputation of these interested in local manufacture, referred to in our article on "Australian Industries" of December 24 last, waited upon the minister and received a somewhat encouraging reception at his hands, it would have been interesting to have seen what interpretation Mr. Lyne would have put upon the elastic expression "within a certain distance of the tenders from manufacturers outside the colony." But as the Government of Sir Patrick Jennings, of which Mr. Lyne was a member, has since given way to the Government of Sir Henry Parkes, it will fall to the lot of another minister to receive the tenders and give definite form to Mr. Lyne's vague "stipulation." Sir Henry Parkes enters upon office as a staunch supporter of free trade, a policy which, we believe, he has steadily advocated ever since he began his long political career, as being best in the interests of the community at large. Whether he will be able to carry the country with him, or—a matter of equal importance—whether, in the event of his party remaining in power, the Minister for Works, on whom shall devolve the duty of dealing with the tenders, will loyally uphold the principles of the party, or will be tempted, under the free-and-easy mode of dealing with such matters, to curry favour with the manufacturing portion of the community by giving in their interests a free interpretation to Mr. Lyne's stipulation, remains to be seen.

The Institution of Mechanical Engineers.

The fortieth annual general meeting of the Institution of Mechanical Engineers commenced yesterday evening, and will be continued to-night. The meeting is being held at the Institution of Civil Engineers, the Council having, in accordance with their custom, placed the theatre at the disposal of the members of the sister Society. The meeting opened with the usual formal proceedings. Mr. E. H. Carbutt is the new President, Mr. Jeremiah Head retiring after his two years' term. There were three papers on the list, but before they were heard the meeting proceeded to the adjourned discussion on the late Mr. Robert Wyllie's paper on the "Triple-Expansion Marine Engine," which had been left over from last meeting. This, together with the other proceedings, we shall deal with in our issue of next week. The annual report of the Council shows that the Institution continues to prosper. The number of names in all classes on the roll at the end of last year was 1674, a net gain of 34. The total number of new members 103, but there were 17 deaths and 52 resignations or removals. The year's receipts were 5701*l.* 15s. 11d., and the expenditure 4652*l.* 12s. 5d. The capital of the Institution now amounts to 18,574*l.* 18s. 3d. The further experiments in the research upon rivetted joints with thicker plates, larger rivets, and heavier pressures have been delayed owing to the Netherton testing machine not being completed. Some fresh apparatus is being constructed for further experiments by the Friction Committee. Another research committee has been appointed to look into the question of the steam jacket, Mr. Henry Davey, of Leeds, being about to conduct the experiments. Yet another research committee is going to draw up a standard system for conducting marine engine trials, Professor Kennedy having undertaken its organisation. The three papers set down for reading at the present meeting are as follows: "Notes on the Pumping Engines at the Lincoln Water Works," by Henry Teague, of Lincoln; "Description of a Portable Hydraulic Drilling Machine," by M. Marc Berrier-Fontaine, of Toulon; "On Copper Mining in the Lake Superior District," by Mr. Edgar P. Rathbone, of London.

Glow Lamp Patents.

On Monday last the judgment of the Court of Appeal in the case of the Edison and Swan Electric Light Company *v.* Woodhouse and Rawson, was given. The judges were Lords Justices Cotton, Fry, and Bowen. It will be remembered that the chief interest of the original action was centred on the second claim of one of Edison's glow lamp patents, in which he defined his invention as "the combination of a carbon filament within a receiver made entirely of glass, through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth." The case turned very much on the meaning of the word "filament," as a lamp had, previously to the date of the patent, been exhibited by Swan, containing all the elements of the combination claimed, except that the conductor was a fine carbon rod. Mr. Justice Butt, in the first action, held that a carbon filament must have the qualities of flexibility, resiliency, and a high degree of resistance. The three judges of appeal were divided. Lords Fry and Bowen held that Mr. Edison used the filament instead of the rod for a definite purpose, and by the diminution of the sectional area, made a physical law subserve his ends. The point at which Edison's instrument departed from Swan's was crucial, and the departure, though slight, had the merit of a new invention and produced a new apparatus. Lord Justice Cotton took another view; he considered that an examination of the whole specification did not lead up to a claim for a combination including carbon filaments generally, or that a filament meant carbon of extreme minuteness of sectional area, having the qualities of flexibility or resiliency, or that all such filaments were claimed. On the contrary, he found no such qualities described, and the only flexibility the inventor had in his mind was a flexibility of the original material. The result of this trial is to leave the defendants in a worse position than before, for two appeal judges have widened the definition of a filament as laid down by Justice Butt, and one might almost imagine that they considered the word applicable to any carbon conductor which would serve successfully in an electric lamp. We suppose that the House of Lords will now be invoked to give a third definition of "filament."

Diverting the Oxus to the Caspian.

The Tiflis authorities are much interested just now in the question of diverting the Oxus to the Caspian, an idea of Peter the Great's, which has often been recommended of late years, but without entering upon a practical stage until recently. In the present form of the project, it is proposed to cut the bank of the Oxus near the new railway station at Chardjui, and carry the water through a series of old river cuttings, across the Transcaspian desert to Balkan Bay. The advocates of the scheme state that it would be possible to do this without impairing the water supply of Khiva, whose very existence depends upon the irrigation canals running out from the Oxus; and moreover, in sufficient volume to enable the water way to be navigated by steamers. The official newspaper *Kavkaz* has taken up the idea warmly, and published numerous articles, based on the latest surveys, in support of it. The adverse decision of a Commission appointed some years ago, when the idea of diverting the Oxus just above Khiva was mooted, does not, according to its view, affect the present issue. That Commission traversed ground quite

different from that at present contemplated, and which moreover was handicapped by the depression of the Sari Kamish, into which the Commission reported the Oxus would flow without filling it up, and simply create another Aral Sea closer to the Caspian. In the present instance the construction of the railway from the Caspian to the Oxus has furnished a series of levels throughout demonstrating that south of the watershed, between Sari Kamish and the railway, the ground is most favourably adapted for a waterway. Associated with the project is the construction of intermediate oases, for the cultivation of cotton, and the establishment of storage reservoirs for water. In the autumn there are heavy falls of rain, and in the spring abundance of water from melted snow, both of which are at present allowed to disappear in the sands. By improving upon the methods of storage long in use among the Turcomans, it would be possible to form a large area of cultivable territory, which in time would increase still further with the growth of vegetation, sheltering the fields and the reservoirs from the rays of the summer sun. In this manner the success of the waterway would not be dependent upon shipping only. Even if the scheme failed in this respect, it would be successful in opening up to cultivation large stretches of fertile clayey soil, which are simply deserts to-day, because there is no water to irrigate them in summer.

NEW SUBSIDISED STEAMERS FOR THE AMOOR.

According to the *St. Petersburg Viedomosti*, the Russian Government has decided upon subsidising a line of steamers to run on the River Amoor, from Sretinsk to Nicolaevsk, at the mouth. The steamers are to be sixteen in number, and run between the two points three times a month, besides performing postal duties oftener between intermediate towns. Commencing with the present year, the sum of 245,000 roubles, or 24,500*l.*, will be annually granted as a subsidy, and a salary of 600*l.* a year assigned to an official of the Department of Trade and Manufactures to see the conditions of the concession properly carried out. Whether the steamers are to be constructed in Russia or abroad is not stated, but, in view of the anxiety of the Government to establish the service as quickly as possible, we should imagine that the latter will probably be the case. The addition of this subsidy to the other onerous ones already existing testifies to the importance attached by the Russian Government to the development of its power in the far East. Besides paying a heavy mileage rate to the Black Sea Steam Navigation for running steamers to the China Seas, the Government maintains expressly for the same service the Volunteer cruiser fleet, and grants a further subsidy to the Saghalien Steamship Company. Latterly the discovery of the immense deposits of gold in the Chinese territory bordering on the Amoor has called the attention of Russia strongly to that quarter, and a recent telegram stated that she had made some annexations. This remains to be confirmed, for the Chinese have all along been on the alert, and by means of the Sungari, which flows into the Amoor, could despatch a larger force against Russia than the latter could assemble to resist them. In point of fact, it is the desire to keep ahead of the Chinese, who are developing their strength in Manchuria by establishing military colonies, that has probably been one of the causes contributing to the formation of the present Amoor Company. When the steamers commence running, the journey across Siberia will be materially abridged. A glance at the map will show that the lateral course of many of the Siberian rivers, among them the Amoor, contributes to the perfecting of steam communication. Every year the railways of Russia are pushing further east into Siberia, and the time is not far distant when, by coupling the lateral rivers with railways, and enlarging the steamboat service on some of them, it will be possible to traverse the whole of Northern Asia by steam.

STEEL RAILS IN RUSSIA.

The new Russian Minister of Finance, Vishnigradsky, has signalised his accession to power by ordering that for the future the bounty on steel rails manufactured in Russia is only to be paid on those that can be proved to have been made of Russian metal. Hitherto the bounty has been paid indiscriminately to firms using Russian metal and those using metal imported from abroad; although theoretically it was supposed to be paid only to the former. The effect of the new order will be, if carried out, to place the steel rail makers at St. Petersburg at a disadvantage with those in South Russia and the Urals. Some time ago we pointed out that ironmasters in Russia come under two categories: those who smelt the ore on the spot and manufacture rails, &c., from the purely Russian article, and those who import iron scrap, &c., from abroad, and mix it with what can be obtained in Russia itself. The former are known as "self-reliant" ironmasters, and the latter as "dependent" ones. The "dependent" ones were called into existence twenty years ago, when railway enterprise was commencing in Russia, to redress the deficiencies of the Ural ironmasters. Allowed to import foreign iron duty free, and encouraged by a bounty, they rapidly developed the rail-making industry at St. Petersburg and other points on the littoral, and most of them realised large fortunes. With very few exceptions, however, with their death or retirement, their works have fallen into decay, owing to the extravagance or incapacity of their successors, and economical causes; and now the policy is to encourage afresh the ironmasters of the Urals and South Russia. On their behalf the late Minister of Finance imposed a duty on foreign iron imported into Russia, and the present one, by ordering that steel rails rolled at St. Petersburg shall be made of Ural or South Russian iron, obviously places the St. Petersburg ironmasters at a decided disadvantage with those of Siberia and the sonth. Whether this policy will be successful remains to be seen. We very much doubt it. To elevate an industry in one part of the empire by depressing it in another is a curious form of protectionism which no political economist can support. The fact of the matter is that protectionism has landed Russia into so many difficulties that the present policy is bound to be often inconsistent. In general the new order will hurt the foreigner very slightly, while it will render still more difficult the task of providing Russia with cheap railways, thereby injuring the corn trade, which is suffering from such severe depression, owing to the lack of ready transport. As the condition of the corn trade determines the general condition of Russia the policy of injuring it to favour the puny iron industry can hardly be designated very wise.

THE MANCHESTER SHIP CANAL.

The third ordinary general meeting of the Manchester Ship Canal Company, which took place on Tuesday last, revealed an unfortunate difference of opinion on the Board. It will be remembered that during the summer of last year an independent committee of gentlemen interested in the trade of Lancashire and Yorkshire, undertook, at the instigation of the Mayor of Manchester, an investigation of the prospects of the canal scheme, both from an engineering and a financial point of view. After a long deliberation they reported* that the project was sound, and was worthy of the support of the public, but at the same time they added an urgent recommendation that the Board should be strengthened. The proceedings of the Committee extended over a considerable period, during which a difference of opinion arose among the directors. A part of them, including the chairman, Mr. Daniel Adamson, were anxious to take further steps to raise capital, while the remainder considered it their policy to await the report of the Committee. As the latter part of the directors were in the majority this course was followed, and when the report appeared a pledge was given that an effort should be made to reconstitute the Board. The chairman endeavoured to carry out the promised reconstruction, but as he found himself unable to do so, he urged his colleagues to proceed at once to raise further capital. It appeared to Mr. Jacob Bright and to Mr. W. H. Houldsworth that this course was incompatible with the pledge which had been given, and they resigned. Nearly all the remaining directors then offered to resign, and the result has been that Mr. W. H. Houldsworth, M.P., remains off the Board; that Mr. Alderman Husband, Mr. William Fletcher, Mr. Richard James, and Mr. John Rogerson have vacated their seats; and that Mr. Daniel Adamson, Sir J. C. Lee, Mr. Jacob Bright, M.P., Mr. Alderman W. H. Bailey, Mr. Henry Boddington, Mr. W. J. Crossley, Mr. Joseph Leigh, Mr. S. R. Platt, Mr. J. E. Platt, and Mr. John Rylands remain upon the Board, thus leaving five vacancies. All the directors who have retired have done so solely with the object of facilitating the reconstruction of the Board, and of advancing the interests of the undertaking. At the meeting the majority offered a report to the shareholders containing the facts set forth above, and suggesting the names of Lord Egerton of Tatton, Mr. J. K. Bythell, Mr. Charles J. Galloway, and Mr. Charles Moseley, as gentlemen who should be invited to join the Board. The report was adopted by the meeting, whereupon Mr. D. Adamson announced his intention of resigning. It will be a great pity if Mr. Adamson should persist in leaving the Board. Financial necessities appear to require that he should vacate the chair, but after the splendid efforts he has made on behalf of Lancashire, and which, probably, no other man could have done, it would be matter of extreme regret for him to separate himself from the future history of the canal. In any case, however, his labours in connection with its inception and development will always be remembered, and if it succeeds —as we trust and believe it will—he will require no other monument. It appears that the total expenditure of the company up to the present has been 152,602*l.* 16s. 7d., and that during the past few months large scale surveys of the route of the canal have been made.

* See ENGINEERING, vol. xlii., page 622.

NOTES FROM THE SOUTH-WEST.

Street Repair at Gloucester.—At a meeting of the Gloucester Town Council on Tuesday, the Street Committee recommended that tenders should be obtained for the supply of 1000 or 2000 tons of Bristol black rock, Chepstow blue rock, or Wickwar stone. It was objected that this was a new departure from the established use of the Cleehill stone; but it was explained that it was only proposed to use the stone intended to be purchased in the repair of side streets, and that one object in purchasing it was to provide employment at stone breaking for men who would otherwise be unoccupied. The council authorised the committee to accept a tender for 1000 tons.

The Caerphilly Foundry.—This foundry is about to be restarted by Mr. C. Lawrence, of Taff's Well.

H.M.S. "Mersey."—The catches of the Mersey's submerged torpedo tubes have been discovered to have some defects, which prevent their closing properly. This will necessitate the vessel's being docked, thus postponing her trial under the superintendence of the officers of the Vernon for at least a week.

Pontypool.—On Wednesday, Major Tulloch, one of the inspectors of the Local Government Board, held an inquiry at Pontypool into an application of the Local Board for powers to borrow 5000*l.* for the works required for the widening and improvement of George-street. Major Tulloch, after hearing evidence, said the plans submitted to him showed that the proposed improvement was an obvious one.

Swansea.—The annual meeting of the Swansea Chamber of Commerce was held on Friday. The report, which was read by the secretary (Mr. E. P. Jones), stated that negotiations between the Swansea Town Council and the Great Western Railway Company had been completed, and the way was now clear for the erection of a much needed high tip at the North Dock. The assimilation of harbour rates to those in force at Cardiff had been accomplished, and the harbour trustees had given another instance of their spirited policy by allowing vessels using the port for repairs only, to do so free of tonnage rates, subject to certain conditions. The trade of the harbour had shown a marked decrease in the total imports, and the falling off in the exports of coal and fuel continued, although to a less extent than between 1883 and 1884. It was, however, satisfactory to record that the exports of tin plates were constantly on the increase. The shipments during 1886 averaged close on 4000 tons per week, the total being 191,373 tons, an increase of 27 per cent. on 1885. The number of boxes shipped to America was 2,109,999, being 48 per cent. of the entire export from the United Kingdom to that country. The number of steamers visiting the port for bunker coal indicated that Swansea's superior geographical position was becoming more generally acknowledged.

Newlyn Harbour.—In June, 1885, the foundation stone of the south pier of Newlyn Harbour was laid by Mr. C. C. Ross. The undertaking is now virtually completed. The pier, which juts out into the sea 720 ft., is approached by a slip of considerable length and gradient, which is supported on the north side by a very substantial and carefully-built granite wall. From the bottom of the slip the pier runs out in a straight line for 360 ft. in an easterly direction, on what are known as the Garrick Sewwens rocks. The parapet, which is on the south side, has a variable height of from 5 ft. to 8 ft. There are two flights of steps leading down to the water's edge, one at the angle and the other at the point, and at the land end there is a cart-road and slipway leading to the beach. The pier is mainly built of concrete, the coping and pitching, and also the steps, being of granite, supplied by Messrs. Freeman and Son. No blasting was required for preparing foundations, as the concrete was simply deposited on the solid rocks, which throughout the whole length, form the bed of the pier. At the point of the pier a wrought-iron lighthouse tower, with lantern, lens, and reflectors is being erected. It is 27 ft. high to the focus, and will be supplied with Lindberg's patent occulting apparatus, as it will show a white flashing light. The contractors for the lighthouse are Messrs. Jukes, Coulson, Stokes, and Co., London. Mr. J. C. Inglis, of Plymouth, has acted as engineer of the harbour works, and the new

pier has been constructed by Messrs. Hill and Co., under the supervision of Mr. Lester, one of the firm. The contract amounted to 16,925*l.*

Bristol and South Wales Railway Wagon Company (Limited).—The directors, in their half-yearly report, state that the business of the company during the past half-year has been satisfactory. The directors have carried 500*l.* to the contingent fund. The revenue account thus shows a disposable balance of 5540*l.* 2s. 8d., and the directors recommend that a dividend be paid at the rate of 10 per cent. per annum, free of income tax, leaving a balance of 425*l.* 2s. 8d. to be carried to the current half-year's account. The rolling stock of the company now consists of 11,033 wagons and carriages, and thirteen locomotives.

Newport Water Works Company.—A Wharncliffe meeting of this company was held on Wednesday for the purpose of considering the provisions of a Bill now before Parliament for obtaining powers to construct new works and raise additional capital. Mr. J. Lawrence presided. The chairman said the scheme in hand would involve an expenditure of about 150,000*l.* The directors were aware that the supply at present was sufficient for a population of 50,000, but the company must provide for a larger future consumption. The scheme which the directors had in view was, first of all, to construct a storage reservoir at Llanvaches. This reservoir would, according to the engineer, contain something like 280,000,000 gallons, and would be supplied in part from one valley and in part from another, both springs originating in the forest of Wentwood. The company asked Parliament for five years to complete the purchase of land, and twelve years for the execution of the contemplated works. The Bill was approved.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig-Iron Market.—Last Thursday's market was somewhat depressed in tone, and although prices did not close at the lowest, still there was a decline all round, and more especially in hematite pig iron. At one time Scotch pig iron was down in price 6½d. per ton, but the close was 45s. 3½d., or 1d. lower than the closing quotations on the previous day. Cleveland warrants declined in price 4½d. per ton, but recovered 2d., and closed at 36s. 8d., or 2½d. lower. There was a severe drop in the price of hematite pigs, the quotations being at one time 1s. per ton down, of which 1½d., however, was recovered, the close being 50s. per ton. A further decline in the prices of pig iron took place on Friday; even the continuance and the extension of the strike amongst the miners did not keep prices from dropping, although in the afternoon the report that the Northumberland miners had lifted their tools caused a slight recovery. At the close Scotch warrants showed a drop of 3½d. per ton, making 1s. 6d. per ton on the week. The highest price in the forenoon was 45s. 4½d. cash and 45s. 7d. one month, and the lowest quotations in the afternoon were 44s. 10d. cash and 45s. 1d. one month. Over the week the decline in the price of Cleveland warrants, was 1s. 7½d. per ton, and the price of hematite warrants was 1s. 3d. per ton down over the week. The depressed feeling was again very evident on Monday. Business was done in Scotch pig-iron warrants down to 44s. 8d., but at the close the price was ½d. per ton better. The decline from the highest price, which was paid on the 13th of January, was 2s. 11½d. per ton. There were some light transactions in Cleveland iron, but the closing quotation—36s. 3d. cash buyers—was 3s. under the highest quotation on the 19th of January. The closing price of hematite warrants was 49s. 3d., or 2s. 10½d. under the highest quotation during the "boom," which was reached on the 21st of January. Yesterday's market also showed considerable depression, and all kinds of warrant iron suffered a further decline in prices. Scotch warrants fell from 44s. 8d. to 44s. 2d. per ton, from which there was a sharp rally to 44s. 5d., the market closing with buyers at that price and 44s. 8d. one month. There were numerous transactions in the course of the day. A large amount of business was also done in Cleveland and hematite warrants, the closing prices of which were, respectively, 36s. per ton (a fall of 3d.) and 48s. 6d. (a drop of 9d. per ton). At the close of the market Scotch warrants had lost all the advantage made from last year's close and 1d. besides; but the price of Cleveland iron was still 10½d. per ton above the closing price in December. while the price of hematite warrant iron was 2s. 4d. higher than last year's closing quotation. This forenoon prices again receded, Scotch warrants, 6d. per ton; Cleveland, 3d.; and hematite warrants, 9d. per ton. The closing quotations in the afternoon for Scotch iron were: Sellers, 44s. 5d. cash and 44s. 8d. one month, with buyers at 1d. per ton less. From these daily reports of the Glasgow warrant market, it will be seen that the "boom" is quite off; indeed, there is now no doubt that the advance in prices was forced up by speculators with undue rapidity, and far beyond the *bonâ fide* demands for pig iron both at home and abroad. It is not unlikely that legitimate investors will now go in and make purchases on advantageous terms. Fresh orders from the United States seem to be in abeyance for the present, but there are still considerable shipments being taken to American ports. The number of blast furnaces in actual operation is still at 76, as against 95 at this time last year. One was relighted at Dalmellington Iron Works during the week, against which one was blown out at Glengarnock Works. The shipments of pig iron from all Scotch ports during the week ending last Saturday amounted to 7988 tons, as against 4962 tons in the preceding week, and 6611 tons in the corresponding week of last year. The United States took 1100 tons; India, 200 tons; Australia, &c., 235 tons; France, 260 tons; Italy, 3299 tons; Holland, 580 tons; and other countries took smaller quantities. Yesterday afternoon the stock of iron in Messrs. Connal and Co.'s public warrant stores was 842,169 tons, as compared with 841,959 tons yesterday week, thus showing an increase for the week of 210 tons.

The Steel Trade.—The second advance of 5s. per ton which was lately put on the price of Scotch Siemens steel seems to have checked the placing of new orders; it is certainly the case that very few, if any, have been booked at the higher rates mentioned in last week's "Notes." It is confidently stated that makers all round are quite willing to take orders at the rates reached by the first advance of 5s. per ton. Most of the works are fairly well occupied with contracts that will keep them actively employed for some time. The production of basic steel in the shape of blooms, billets, &c., at the Glengarnock Steel Works is at present very active, the material turned out being chiefly for America and for the tin-plate works in South Wales.

Electrical Engineering in the University of Edinburgh.—As a sign of the times in the educational world, it may be mentioned that arrangements are being made for starting an electrical engineering class in connection with the Baxter Chair of Engineering and Mechanics in the University of Edinburgh. The class, which is to be conducted under the superintendence of Professor Armstrong, by his assistant, Mr. A. C. Elliott, B.Sc., is to be engaged in studying the practical applications of electricity to lighting, locomotion, transmission of power, and telegraphy.

Royal Society of Edinburgh.—An ordinary meeting of this Society was held on Monday night, Dr. John Murray, vice-president, in the chair. The first paper, which was read by Professor Armstrong, was by Mr. A. C. Elliott, B.Sc., and its title was "On a New Formula for the Pressure of Earth against a Retaining Wall." It was pointed out in the paper that in the method laid down by the late Professor Rankine no allowance was made for friction between the earth and the retaining wall, but only for friction amongst the earth itself, looked upon as a granular mass. By accepting Rankine's theory generally, and taking into account this friction between the earth and the wall, Mr. Elliott deduced a formula which, so far as it had been tested, appeared to give results much more in accordance with practical experience than those obtained by Rankine's method.

Extraordinary Iron Ore Imports.—During last week nine steamers arrived in Glasgow Harbour from Bilbao, and discharged 10,482 tons of hematite ironstone. Other three steamers from Bilbao discharged their cargoes of the same mineral, amounting to 3637⅓ tons, at Port-Glasgow, to be conveyed thence by the Caledonian Railway to the iron works of Lancashire. Such a large number of steamers arriving in the Clyde with iron ore from Bilbao in one week is quite unprecedented.

Clyde Shipbuilding Trade—Launches in January.—There was a fairly good average tonnage of new shipping launched from the Clyde shipbuilding yards during the month of January. The month's output included ten vessels, of a total of 14,700 tons. This total shows an increase of 7260 tons over the output in January of last year, and of 3050 tons over the output for January, 1885, but 8900 tons under that for January, 1882, which was the highest tonnage launched during the first month of the year for a considerable period. Of the vessels launched last month eight were steamers of a total of 12,100 tons, and two sailing vessels aggregating 2600 tons. The largest vessel in the month's output was the "Glen" Line steamer Glenshiel, of 3500 tons, built for Messrs. M'Gregor, Gow, and Co., London and Glasgow. There were other two large steamers in the month's output—the Bellaura, of 2800 tons, and the Queen Victoria, of 2400 tons—both built for Glasgow firms.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday there was a better attendance on 'Change, but there was very little business doing. The market was not only dull, but prices were weaker, owing to weak holders being alarmed at the Continental war rumours and realising. There is still a satisfactory demand, and although the shipments of iron from Middlesbrough during January have been small—51,800 tons—the stocks of Cleveland iron for last month will not have increased much. It is believed that when the shipping season begins the stocks will be rapidly reduced. No. 3 Cleveland pig iron for early shipment is quoted 36s. 3d. to 36s. 6d. per ton. Hematite pig iron is now selling at 49s. to 49s. 6d. per ton for mixed Nos. 1, 2, and 3 east coast ports. The manufactured iron trade is easier. Iron ship-plates are selling at 4*l.* 17s. 6d. per ton, angles 4*l.* 12s. 6d., steel ship-plates 6*l.* 5s. to 6*l.* 10s., and angles 5*l.* 17s. 6d., all less 2½ per cent. at works. Steel rails are selling at 4*l.* 10s. per ton f.o.b.

Engineering and Shipbuilding.—Not only do engineers and ironfounders keep fairly well occupied, but shipbuilders are getting a few more orders for new vessels, mostly of steel. On the northern rivers there is a more active appearance than there was a month ago, and it is hoped that orders will continue to come to hand. A few days ago the Sunderland Shipbuilding Company, Limited, launched from their yard a screw steamer built to the order of the Jersey, Guernsey, and St. Brieux Steamship Company. This beautiful steamer is specially designed for the Channel passenger trade, has been engined by Mr. John Dickinson, of Sunderland, and will attain a high rate of speed.

The Board of Arbitration.—The accountant to the Board of Conciliation and Arbitration for the Manufactured Iron Trade of the North of England, has issued the returns for the two months ending December 31, showing the production and prices of manufactured iron. From these it appears the make of rails has been 412 tons and the average net selling price 4*l.* 6s. 4d. per ton, plates, 28,495 tons, 4*l.* 8s. 11d., bars, 12,490 tons, 4*l.* 18s. 4d., and angles, 6331 tons, 4*l.* 7s. 6d.; or a total of 47,730 tons at 4*l.* 11s. 2d. per ton. This is 4d. per ton lower than the prices during the previous two months. The annual meeting of the Board was held at Darlington on Monday. It was stated that the membership of the Board remained the same, viz., ten firms owning twelve works. The number of operative subscribing members was 3524, an increase of 397 on the number reported six months ago. The balance in hand at the end of the year was 644*l.* 12s. 10d. The committee congratulated the members of the Board on the somewhat improved out-look in the condition of trade throughout the country generally, but they could not say that any appreciable improvement had been experienced in the finished iron trade. Prices were in fact lower than ever previously, while the rise in raw material had operated very prejudicially in the interests of the trade with which the Board had more particularly to deal.

The Steel Trade.—The steel trade continues very busy, and prices are firmer. The men at Messrs. Bolckow, Vaughan, and Co.'s Eston Steel Works, near Middlesbrough, have struck, their notices to leave work having expired on Saturday. They insist upon an advance of 10 per cent. in wages, and suggest that the question should be submitted to arbitration. The company decline to grant any advance at present, and say that there is no ground to arbitrate upon. There are about 2000 men idle, and as they are not organised, it is not expected that they will remain off work more than about a fortnight at longest. It is matter for regret that the steel workers are not associated with the Board of Arbitration. Had they been connected with that body, their differences could have been amicably settled without any stoppage of work.

The Coal and Coke Trades.—The Northumberland pitmen, as we feared, are idle, having refused to submit to a reduction in wages. Here is another illustration of the value of arbitration. If the coal trade had been associated with the Board of Arbitration in the iron trade, the wages question might have been arranged without any stoppage of work, which is injurious both to employers and operatives.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Improvement in the Hull Shipping Trade.—The improvement which has been previously noticed in the shipping trade of Hull still continues. There was a decrease in both the outward and inward tonnage during the past week as compared with the previous week, but in comparison with the corresponding period of 1886, there was a decided improvement, and imports and exports were better all round. The vessels reported at the Custom House as having arrived from foreign ports had a total of 37,514 tons against 44,061 tons in the previous week, and 31,334 tons in the corresponding week of last year. The vessels leaving on oversea voyages had a total of 20,648 tons, against 24,265 tons in the preceding week, and 16,828 tons in the corresponding week of 1886.

Scarborough Valley Bridge Company.—The report of this company, just issued, shows that the balance standing to the credit of the revenue account, for the year ending December 31 last, is 2108*l.* 4s. 2d., inclusive of 509*l.* 12s. brought from last year's account. The directors recommend a dividend of 10 per cent. per annum, and that the sum of 250*l.* be added to the reserve fund.

British Wagon Company, Limited.—The report of the directors of this company, to be submitted to the shareholders at the thirty-sixth half-yearly meeting, was issued last night. The balance standing to the credit of profit and loss account is 2377*l.* 15s. 4d. The directors propose thereout to pay a dividend of 6 per cent. per annum on the paid-up capital of the company, free of income tax, to place 500*l.* to the reserve fund, and to carry forward a balance of 92*l.* 9s. 5d.

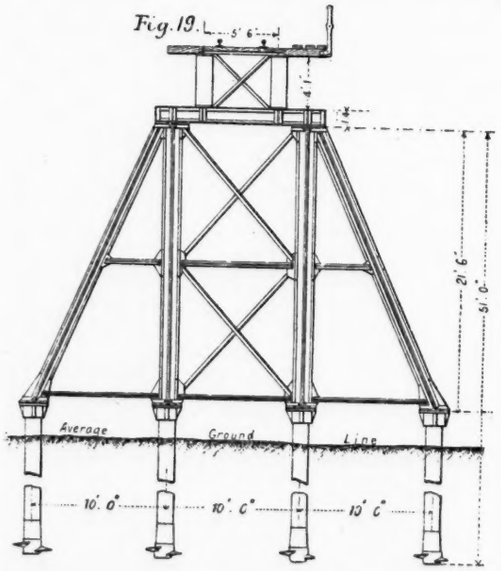
New Sharlston Colliery Company.—The directors of this company have resolved to declare a dividend of 5*l.* per share for the year 1886.

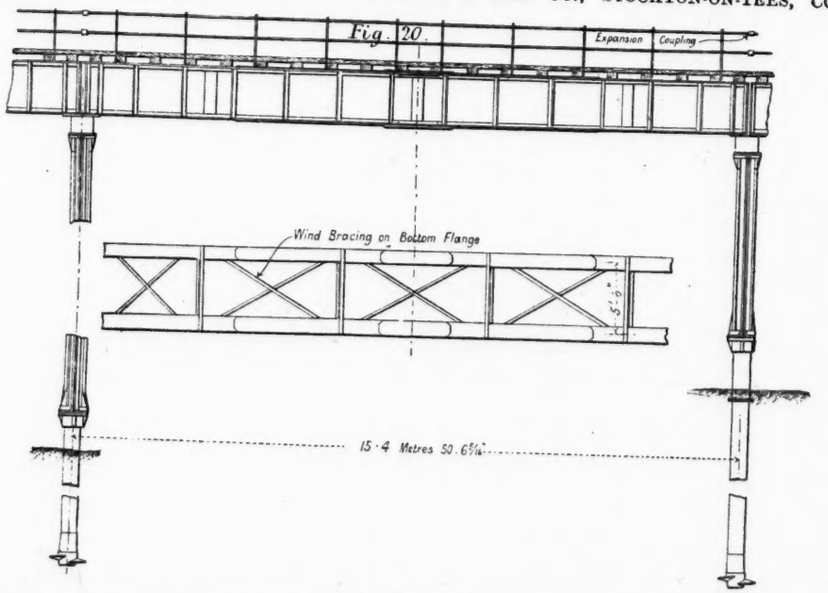
The Effects of Blasting.—On Saturday morning last operations were undertaken at the Atlas Works (Messrs. John Brown and Co., Limited) by Messrs. Roper and Co., of Sheffield. A solid mass of metal, known as a cupola bottom, "old bear," or "cat's brain," composed chiefly of iron and spiegeleisen, 3 ft. or 4 ft. in depth, and 9 ft. in diameter, was rent asunder like matchwood, although it was of immense strength and tenacity. The work was undertaken under the superintendence of Mr. Liversidge, with the assistance of Mr. Louie, the engineer and instructor in the use of dynamite to the company. The first shots were extremely successful in their results, not a particle of the metal being lodged beyond a distance of six or eight yards from the seat of the explosion.

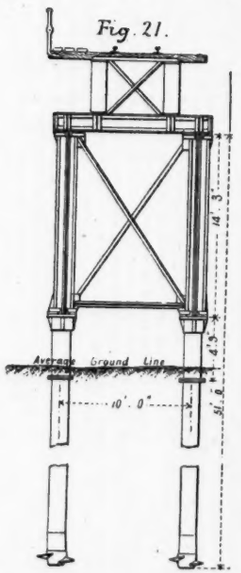
Swedish Guns.—The Swedish Government has during the past year received the following quantity of guns, &c., which have all been manufactured within the country. One 16-centimetre gun, four 16-centimetre Houbitz guns, eight 12-centimetre guns, twenty 8-centimetre guns, besides a number of various appliances, gun and ammunition carriages, &c. The ammunition amounts to 1200 16-centimetre projectiles, 1200 12-centimetre, and 21,000 8-centimetre projectiles. Twelve 12-centimetre guns and fifty-four 8-centimetre guns are in hand.

BRIDGE OVER THE IBICUY RIVER; GREAT SOUTHERN RAILWAY OF BRAZIL.

MR. ALFRED RUMBALL, M. INST. C.E., ENGINEER; MESSRS. HEAD, WRIGHTSON, AND CO., STOCKTON-ON-TEES, CONTRACTORS.







We illustrate, on our two-page plate and also on the present page, an important bridge, now being constructed by Messrs. Head, Wrightson, and Co., for carrying the Brazil Great Southern Railway over the Ibicuy River. It is of a total length of about 3953 ft., or three-fourths of a mile (Fig. 1), and is divided into sixty spans of 15 m. each (Figs. 19 to 21), forming the approach viaduct; and four spans of 70 m. each (Figs. 2 to 4), over the main channel, or waterway. The railway, which is of metre gauge, is carried on the top of the main girders in the approach spans (Fig. 21), and on the bottom in the main spans (Fig. 3). The superstructure of the 15 m. spans is formed of two-plate girders of the ordinary type, 50 ft. 4 in. in length by 4 ft. deep over the main angle irons; they are placed 5 ft. 6 in. apart, centre to centre, and are provided with transverse and horizontal bracing. The sleepers, which are of 9 in. by 6 in. timbers, are spaced about 2 ft. 8 in. apart, centre to centre, and are carried out on one side to form bearers for a platelayer's track, or footway, which is of three 9 in. by 3 in. planks. On the projecting ends of the timbers are secured the standards for carrying the parapet railing, which is of two tiers of gas tubing, 1 in. bore. The piers for these approach spans are of two types, 33 being formed of two piles (Fig. 21) and 26 of four piles (Fig. 19), 15 in. in diameter and 1 in. metal, with external faced flanges; the screws (Figs. 9 to 11) are 3 ft. in diameter, and of 2 in. metal at the root of the blade. The piles are surmounted by cast-iron caps (Figs. 7 and 8), on which the upper portion of piers rest; the verticals in both types of pier are of pillar iron section, 12 in. internal diameter; the four-pile piers have, in addition, raking struts, of built girder section, the whole being braced together with horizontal and diagonal bracing. On the top of the upper portion of the piers are bed girders, box section, 12 ft. 8 in. and 12 ft. in length, for their respective piers. On these bed girders, and bolted to them, rest the main girders, provision being made in their ends for expansion and contraction by means of slotted holes. The superstructure of the four main spans is formed of main girders of the "Whipple-Murphy" type (the end or main struts being inclined); they are each 228 ft. between centres of bearings, 25 ft. 8½ in. deep over the main angle irons, and placed 15 ft. 7½ in. apart centre to centre, and have flanges 2 ft. 6 in. in width; they are divided into eighteen bays of 12 ft. 8 in. each; the main booms and end struts are of trough girder section formed of plate and angle iron; the vertical struts are of four angle irons with lattice bar bracing; the diagonal ties being of flat bars and towards the end, where the width is great, of ordinary plates. Between the main girders are two sets of overhead transverse bracing formed of lattice girders, the bracing frames being completed by diagonal channel irons. The cross-girders, which are opposite the vertical struts, and connected between the bottom booms, are 1 ft. 8 in. deep, formed of plate and angle iron, with bars rivetted to the top and bottom flanges; between the cross-girders, and rivetted to them, are the rail bearers, 1 ft. 2 in. deep, and on these rest the 12 in. by 6 in. rail balks. On each side of the gauge is a timber footway of 3 in. planking, and parapet railing formed of cast-iron standards, with two tiers of gas tubing 1 in. bore. Wind bracing, of angle iron, is provided to both top and bottom booms (Fig. 4). At the bearings are cast-iron knuckle-plates for deflection (Figs. 15 to 18), together with cast-iron bedplates, and, at one end, sets of rollers for expansion. The piers for these main spans are formed of cast-iron cylinders, 55 ft. in height (Figs. 13 and 14); for 30 ft. from the base they are 10 ft. in diameter, a conical length then intervenes for a depth of 5 ft.; the upper length of 20 ft. being 8 ft. in diameter. The 10 ft. rings are made up of six, the 8 ft. rings of four segments, the vertical and horizontal joints being faced, and provided with caulking spaces. Above the top of the cone the metal is 1¼ in. thick, below 1⅜ in. A bold circular cap is attached to the top of the cylinders, and two bracing girders, of wrought iron, box section, are bolted between the cylinders, to act as stays or distance pieces. The cylinders will be sunk by the pneumatic process, through the bed of the river, about 18 ft., until they rest on the solid rock; the bottom lengths are provided with a cutting edge, and the cylinders will be filled with concrete. The staging for erection, as well as the apparatus for sinking the cylinders, is being sent from this country.

The total weight of ironwork in the bridge is about 2700 tons divided into 1750 tons of wrought and 950 tons of cast iron.

As previously stated, the bridge is being made and the staging is also being supplied by Messrs. Head, Wrightson, and Co., of Stockton-on-Tees, to the order of Messrs. Perry and Co., the contractors for the railway. The whole is from the designs of Mr. Alfred Rumball, M. Inst. C.E., engineer-in-chief, and is being constructed under the personal supervision of Mr. Jonathan Packman, M. Inst. C.E., inspecting engineer. Dr. Pinheiro, M. Inst. C.E., and M. Alex. Demaret, are the representatives of the Brazilian Government.

THE MAIN DRAINAGE OF THE HOUSES OF PARLIAMENT.

On page 108 we give illustrations of the new drainage works carried out by Mr. Isaac Shone at the Houses of Parliament. The following description is taken from a pamphlet issued by Mr. Shone.

In 1839 Sir Charles Barry laid down, under the Houses of Parliament, a large nearly flat-bottomed brick sewer. (Fig. 1). This sewer, owing to its bad form and other causes, accumulated a large amount of sewage deposit, the gaseous emanations from which continually polluted the air of the palace. In 1846 the smells were so bad that Sir Charles Barry consulted Mr. John Phillips, who recommended that a narrow, deeply curved invert, with a reversed fall, should be substituted for the old invert (Fig. 3).

By the better gradient thus obtained, and by the narrow and deeply curved invert, the sewer as altered became self-cleansing, and it continued in this improved condition for a quarter of a century, until twelve or thirteen years ago. At that time, about 1873, the metropolitan low-level sewer—7 ft. 9 in. in diameter—was put down through Westminster, and the palace sewer was connected with it; its bottom at the junction being about 21 in. above the bottom of the metropolitan sewer.

Ever since this work was done there has been daily, in dry weather, from 3 ft. 6 in. to 4 ft. in depth of sewage flowing on the bottom of the metropolitan low-level sewer, and this created a constant head of sewage against the palace sewer outlet, converting it into a creek, for a length of about 200 ft.—containing from 1 ft. 9 in. to 2 ft. 3 in. in depth of nearly stagnant sewage, which was always present upon the bottom of the palace sewer. But besides this, in wet weather the metropolitan sewer was not only always filled with sewage water, but sometimes this water has risen to 10 ft. above the crown of the metropolitan sewer, or 13 ft. above Ordnance datum.

A discharge of sewage gas into the palace has been going on, more particularly at night time, during the sessions of Parliament, when the gas has been burning throughout the palace, and when the waste hot water and steam from the warming and ventilating appliances of the palace were discharged into the drains and sewers, and fermented the sewage lying therein.

In the early part of 1886 a Committee was appointed, Sir Henry E. Roscoe, F.R.S., being the chairman, to consider if a remedy could be found for the state of things. Among the witnesses was Mr. John Phillips, who submitted to the Committee a plan for again improving the main sewerage arrangements of the palace, and rendering

them perfectly independent of the metropolitan low-level sewer as a means of discharge by gravitation.

The Committee, after consideration, recommended to Parliament that the plan, as proposed by Mr. Phillips, on the Shone hydro-pneumatic system, should be adopted; and their recommendations have been substantially carried into effect.

Fig. 4 is a cross-section of the 1839 sewer, showing, by black colour, the invert waterway necessary to pass through it the maximum quantity of sewage obtaining at the palace when Parliament is in session. Fig. 1 is a longitudinal section of the same sewer, amended and otherwise. It will be seen that the original sewer had a gradient of 1 in 923 only, but by the alteration in 1846 it was increased in 1848 to 1 in 215. Fig. 2 is a sketch plan, showing the Bridge-street sewer outlet into the Thames, as Mr. Phillips recollects it to have been in 1846, and it also shows how the palace sewer was subsequently connected with the Bridge-street sewer outlet. Fig. 3 indicates the erratic way in which the 122 branch drains were connected with the palace sewer in 1839 and 1848. Fig. 5 will be referred to more particularly hereafter, when the nature and value of the new works are explained.

The new works, briefly described, consist (1) in improving the gradients of the main sewer and its principal tributaries; (2) in reducing the sizes of the sewers—the main sewer, for example, from 10 ft. 6 in. high by 3 ft. wide, as per Fig. 3—to one of 12 in. in diameter, as illustrated by Fig. 5. This also shows the waterway on the invert of the new sewer, with its improved gradient, when that sewer is charged with the maximum quantity of sewage which obtains during the Parliamentary sessions. The chief tributary is reduced from 24 in. high by 15 in. wide, and laid at an average gradient of 1 in 372, to a pipe sewer of 9 in. in diameter, laid at a gradient of 1 in 309; (3) in providing superior flushing appliances (Shone's automatic hydraulic flushing ejectors) for the sewers, at a considerably reduced expenditure of water; (4) in providing an improved method of ventilating the main sewers; (5) in forming proper connections between the drains and the main sewers, and giving extraordinary facilities for inspection at the junctions; (6) in severing absolutely the large tunnel-like connection between the palace sewer and the metropolitan low-level sewer by means of a "dam," constructed as per Fig. 7, within the former sewer; in dispensing with the big cumbrous penstock and flap valve arrangements connected therewith, and substituting therefor a small 12 in. iron sewer with sluice and reflux valves; (7) in providing, in case of need, improved automatic arrangements for permitting the palace sewage and rainfall to flow into the metropolitan low-level sewer by gravitation, on the principle heretofore adopted, independently altogether of the ejector system, but without the possibility of the foul gases from the metropolitan low-level sewer getting into the palace sewer; (8) in preventing the hot water and steam from the boilers, &c., from passing into the drains and sewers, and providing a separate and independent outlet for same into the Thames; (9) in providing means whereby the sewage and rainfall proceeding from the Houses of Parliament shall flow uninterruptedly therefrom both in dry and wet weather, irrespective of the height at which the metropolitan low-level sewer is discharging sewage, or sewage and rainfall in combination.

This latter desideratum is effected by means of Shone's pneumatic sewage ejectors, which are fixed in a chamber under the Speaker's Green, near the Clock Tower. These ejectors are placed below the level of the Houses of Parliament main sewer, so that the sewage and rainfall flows to and into them by gravitation. There are three ejectors, one of 500 and two of 350 gallons capacity. They can be worked separately or unitedly, just as the flow of sewage or rainfall is small or large. These ejectors do not, as is the case with pumps, permit sewage sludge or road detritus to accumulate in the pit, sump, or well pumped from; for they themselves become, as it were, the equivalent of so many pits, sumps, or wells, into which the sewage and rainfall flows by gravitation. All foreign matter heavier than water settles on the bottom. The longest time, however, during which this temporary settlement of heavy matter takes place does not exceed fifteen minutes at most, even with the large ejector, and this comparatively long interval of rest to the ejector only happens when the minimum flow obtains, viz., at the time when Parliament is not in session. But, owing to the wash-out shape of the delivery pipe proceeding from the bottom of the ejector, the action of ejection results in the heavier matter being expelled first out of the ejectors, which are thus rendered self-cleansing. The sewage flows freely into the ejector until it reaches a certain determined level. It then operates a float which cuts off the flow and admits compressed air to the vessel. This expels the contents into the low-level sewer and empties the vessel.*

The ejectors are always receiving fresh compressed atmospheric air when the sewage is being expelled out of them, and the surplus of this air—*i. e.*, the volume of air which exerts a pressure superior to that of the atmosphere, and which is innocuous — after each charge of sewage has been ejected, escapes through the exhaust ports of the automatic gear into a pipe which conveys it to the ventilating shaft in the Clock Tower, whence it escapes into the atmosphere. The fresh air, at atmospheric pressure, which remains in the ejector after each action of ejection, flows out of the ejector as rapidly as it is displaced by the fresh charge of inflowing sewage, and that air, which is also innocuous, takes exactly the same route to and out of the Clock Tower shaft as the exhaust compressed air does.

The ejectors are also self-acting; they are emptied in about half a minute; but they take in dry weather, when Parliament is not in session, from ten to fifteen minutes to fill. The compressed air required by the ejectors to expel the sewage and rainfall is supplied by air-compressors, driven by Atkinson's differential gas engines. There are four of these (of 4 horse-power each) situated in the basement of the palace, about 650 ft. from the ejector station. The four gas-engine air-compressors occupy a room which is 20 ft. long, 16 ft. wide, and 9 ft. high.

Figs. 6 to 9 show a plan and section of the pneumatic ejector station, as well as a plan and section of the air-compressing station, &c.

The minimum lift for the palace ejectors is 12 ft., and the maximum lift will probably never exceed 20 ft.

The minimum and maximum quantities of sewage, and sewage and rainfall together, it is now difficult to estimate; but as one of Kaiser's counters is attached to each ejector, a practically accurate record can be kept of the quantities that will be received and ejected from time to time.

From observations already made since the ejectors have been at work, it is clear that one gas-engine air-compressor and one ejector will deal with more than the whole of the largest quanity of sewage flowing from the Houses of Parliament at any one minute of time, even though that sewage should be supplemented by an amount of water equal to 1 in. and more of rain falling upon the entire area of the palace and grounds in twenty-fours.

When one engine and one ejector are insufficient, during periods of extraordinarily excessive rainfall, there is a float within the sewage manhole, adjacent to the ejector chamber, which will rise and fall with the sewage and rainfall, and which will actuate one of Mr. Julius Sax's automatic electrical tidal water gauges (Figs. 10 and 11). This apparatus is fixed within the ejector chamber, and a duplicate of it is also fixed in the gas-engine room, both being very effectively operated simultaneously by the float. These instruments have faces resembling ordinary clocks, and the hands on them denote the exact level, in inches, of the water in the sewage manhole, from which the ejectors are supplied. The moment one engine is overcome the electrical apparatus rings a bell within the ejector chamber, and in the gas-engine room, at the same instant, and then the attendant will set a second gas engine to work; but if the sewage continues to rise in the sewage manhole, notwithstanding the setting to work of a second engine, the electrical apparatus will continue to indicate such increased height, and the attendant will then put a third, and if necessary, the fourth gas engine to work.

Besides having the means of ascertaining the quantity dealt with from day to day, and of seeing how the sewage and rainfall flows to the ejector station, there is also fixed, in the ejector chamber, a semi-mercurial and water-pressure gauge—designed specially for the purpose—by which the exact height of the sewage in the metropolitan low-level sewer can at all times be determined. This gauge is shown on Figs. 12 and 13.

This notice would be incomplete without some further special reference to the relative values of the old and the new main sewers as sewage carriers. The velocity of the flow of the sewage shown on the invert of the sewer of 1839, as per Fig. 4, would be about 1.11 ft. per second, and this volume of sewage would only occupy about the $\frac{1}{12}$ nd part of the entire sectional area of the sewer. Whereas, by the alteration made in the inclination of the sewer in 1848, at the suggestion of Mr. Phillips, the velocity of the same volume of sewage, carried in the new 12 in. iron pipe, laid on the invert of the improved 1848 sewer, as per Fig. 5, would be 2.8 ft. per second, and the waterway area of the latter sewer would be equal to the $\frac{1}{5.4}$th part of the whole. The former is, to all intents and purposes, a non-self-cleansing velocity, whilst the latter, even though the pipe be only submerged to the extent indicated by Fig. 5, would be adequate to render it permanently self-cleansing.

Notwithstanding the enormously reduced size of the palace main sewer, in all human probability the new 12-in. main sewer will never be found more than half-filled, at the outlet, during the greatest rainfall storms; neither will the gas-engine air-compressors or the ejectors ever be required to dispose of anything approaching the maximum quantities which they are unitedly capable of dealing with.

The upper portion of the old sewer is converted into a convenient subway—which is well ventilated—along which workmen can pass to and fro, in comfort, for the purpose of inspecting the condition of the new main sewer and its numerous connections. In case of a complete breakdown, too, of the gas-engine air-compressors and ejectors during periods of heavy rains, this subway would act the part of a reservoir, as it has done heretofore. But this is a contingency which the author thinks can never happen—except, of course, through carelessness—so long as the Houses of Parliament remain free from the influence of severe earthquake shocks.

The ventilation of the new 12-in. main sewer is effected by admitting fresh air into the subway which puts the basement of the Houses of Parliament into direct communication with the ejector chamber, and allowing it to proceed, firstly, along that subway into the ejector chamber; secondly, through the ejector chamber into an air-duct at the top of the eastern end thereof; and, thirdly, along this air-duct into the sewage manhole. The air is made to pass out of the sewage manhole partly into the main 12-in. sewer, and partly through the rectangular air-opening, which communicates with the subway above the main sewer. That portion of the air which passes into the 12-in. sewer proceeds direct to the furnace at the base of the Victoria Tower; but, before diverging from the line of the main sewer, it is joined by the air current which travels from the head of the sewer. Both currents, therefore, go together—from the point of divergence in the new 12-in. main sewer—into and out of the Victoria Tower, along with the volumes of vitiated atmosphere proceeding from the palace.

That portion of the air which passes through the rectangular opening in the sewage manhole into the old sewer subway travels along that subway for a short distance only, when it makes a detour to the right, along with the air that is admitted at the head of the old sewer subway (to ventilate it), and proceeds along an air-duct direct to the furnace at the base of the Clock Tower. The air that ventilates the smaller 9-in. sewer is drawn from the upper end of that sewer to the Clock Tower furnace.

The consumption of cannel coal gas when one engine is running and compressing air to about 10 lb. per square inch continuously for twenty-four hours, is about 2000 cubic feet, which costs—reckoning gas at the price paid for it, viz., 3s. 9d. per thousand—7s. 6d. per day; which is just 3¾d. per hour for the four horse-power engine, or less than 1d. per horse-power per hour.

The works were divided into three contracts, the general contract (No. 1) being let to Messrs. John Mowlem and Co., of Westminster; and the special contracts (No. 2) embracing the supplying and fixing of the pneumatic and hydraulic ejectors, to Messrs. Hughes and Lancaster, Chester; and (No. 3) for the supply and erection of the gas-engine air-compressors, to the British Gas Engine and Engineering Company, Queen Victoria-street, London.

The author is pleased to be able to add that the work, as a whole, has been well and substantially executed without accident, and without there being any practical increase in the cost, which, in round figures, is a little over 11,000*l.*, the amount approximately estimated by the engineer in the first instance, for the guidance of the Treasury and of the Commissioners of Her Majesty's Works and Public Buildings.

* For a description of the Shone system of drainage, see vol. xxviii., page 52.

SEWAGE SLUDGE.

Sewage Sludge and its Disposal.

At the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, January 25, Mr. Edward Woods, President, in the chair, the first paper read was on "Sewage Sludge and its Disposal," by Mr. William Joseph Dibdin, F.C.S., F.I.C., Metropolitan Board of Works.

The author stated that as the subject of this paper was "Sewage Sludge," it was not proposed to consider other than water-carriage sewage. Sewage varied according to the water supply per head of population; quantity of subsoil water; distance it had to be carried before arriving at the works; number of times it passed through pumps, &c. This latter consideration was important, as the greater the agitation the greater the division of the solid matters, and the consequent solvent action of the water. It would be most desirable if measures could be adopted for the deodorisation of fæcal matters before their discharge into the sewers. If this could be brought about, a complete revolution would be effected in the character of all effluent waters after chemical precipitation. The main characteristic of water-carriage sewage was its division into two portions, the liquid and the solid. The quantity of the latter depended upon the treatment the sewage received in the sewers. Great agitation meant fewer solids, and those in a finely-divided state. It was no doubt due to this fact that so many persons were misled in their ideas of what sewage must necessarily be. The average quantity of suspended matter in a dry state, in London sewage, was about 27 grains per gallon. But in many towns it was more than double or treble that quantity. Of the 27 grains about 54 per cent., or 15 grains, were of an organic nature. The liquid portion of the sewage contained, in solution, about 60 grains of solid matter, 33 per cent. of which, or 20 grains, were of an organic character. The solubility of a portion of the suspended matters in solutions of lime seemed to have been entirely overlooked by writers on the subject. The use of an excessive quantity of lime, while affording a rapid settlement of the sludge, and a more or less clear effluent, dissolved a by no means inconsiderable quantity of the offensive matters previously in suspension. To test this, carefully washed sewage sludge was diffused in clean water, the mixture was agitated for five minutes, and a sample withdrawn; an excess of lime was then added, and the mixture again agitated for another five minutes. The limed liquid, instead of containing less dissolved oxidisable organic matter, was found to absorb about three times the quantity of oxygen required by the unlimed liquid. The well-known objectionable character of the liquid pressed from sludge, which had been treated in the usual way with lime, was a striking instance of its action on the solid matters. With respect to dissolved impurities and their partial removal, the author had conducted special experiments for the elucidation of this important point, and had tabulated the results of the examination of varying samples of sewage and of other solutions. The author's experiments showed that strong solutions of organic matter were more readily amenable to treatment than dilute ones.

The results of an exhaustive examination fully confirmed the fact, that no practical process of chemical precipitation was capable of removing more than a limited quantity of the oxidisable organic matters in solution in London sewage. They further demonstrated the superiority of iron over alumina for sewage purification. By the use of iron sulphate in conjunction with lime, as much work was effected (on the basis of the London sewage) for 31,000*l.* per annum as would be obtained by an expenditure of 82,000*l.* for alumina and lime. Alumina was valuable chiefly for its effect in removing some of the colour from the effluent, and thus appealing to the eye-sight, while the matters actually dissolved were there nevertheless. Experiments with animal charcoal showed that when this substance was used to the extent of

182,500*l.* worth per annum, the benefit would be practically *nil*.

In order to test the differences of opinion expressed by various authorities, as to the reduction of dissolved solids by different processes, and to show that no benefit was derived from the use of an excessive quantity of chemicals, the results of a series of experiments on solutions of clear mutton extract were given. These results showed that the same quantity of chemicals was capable of removing from 46 to 90 per cent. of the total oxidisable matter, according to the strength of the solution, and that a large increase in the quantity of the chemicals was of no advantage. These considerations pointed to the general conclusion, that where it was intended to treat sewage by chemical means, the following rules should, as far as practicable, be observed, viz.: That the sewage should be diluted as little as possible; that the flow of sewage should be adjusted so that the agitation of the particles in suspension should be of a minimum character; and that, unless absolutely necessary, no pumping should take place before precipitation. The peculiar conditions affecting the metropolis were exceptional. The want of fall, combined with the necessity for removing the excreta from densely populous districts with the greatest rapidity, combined to insist upon a modification of these rules.

The various methods proposed from time to time for separating the sludge from the liquid sewage were next discussed. The sum and substance of nearly all of them was comprised in the use of lime, either alone or in conjunction with the sulphates of iron and alumina, or of one or both of those salts, alone or in combination with charcoal.

The author objected to an antiseptic treatment of sewage, and discussed the question from the bacteriological point. The method generally adopted for applying lime to sewage was to use it in the form of "milk of lime," in which condition only a small portion was dissolved, and the remainder was in a solid form, in which state it was chemically inactive. If the whole of the chemically effective strength of the lime was to be utilised it must be in solution and not in suspension. If this precaution was observed a few grains of lime would effect as much work as three or four times the quantity when used in the usual form of "milk of lime." When it was considered advisable to increase the effect of the lime, either sulphate of alumina, or sulphate of iron, or both of these substances, in various proportions, were best adapted for the purpose. Alumina salt afforded a less coloured effluent than the iron, while the latter was apt to lead to deceptive appearances when used in excessive quantities.

In choosing between the salts of alumina and iron it was desirable to bear in mind the different chemical changes which took place with the hydrated oxides of these metals when precipitated by lime. Oxide of alumina was precipitated only in the fully oxidised form. On the contrary, oxide of iron was precipitated as ferrous oxide, or the lower state of oxidation, and ferric oxide, or the higher state, according to the condition in which the sulphate existed. The peculiar property of hydrated ferrous oxide was that it rapidly changed its condition from a lower to a higher stage of oxidation in the presence of air. The salt known as protosulphate of iron, or more generally as "green vitriol," afforded ferrous hydrate. This was rapidly converted into ferric hydrate by combination with the oxygen dissolved in the water. In this condition it had the remarkable power of parting with the oxygen thus taken up, and of giving it to the sewage matters. Having thus been reduced to the ferrous state, it was again ready to combine with fresh atmospheric oxygen, which it again yielded up to the sewage, and, acting as a carrier of the oxygen dissolved in the sewage liquid, became an agent for oxidising the more readily attacked foul matters within the limits of the quantity used.

The alternative to precipitation was filtration. This system had been advocated in many different ways; but unfortunately the outcome of them all was the same. Rapid choking of the filters, frequent cleansing, heavy manual labour, unmanageable quantity of sludge mixed with filtering material, &c. As regarded the question of sludge, it was generally admitted that filtration was out of the question. As effecting the further purification of the clarified sewage, filtration was without doubt a rational process in all respects save expense. If further purification was desirable, and suitable land could be obtained, the use of the effluent after filtration for farming was to be commended.

In searching for a material which would remove the odour peculiar to all effluents, by destroying those products of putrefaction which were its source, sanitarians were limited practically to chloride of lime and permanganic acid. The former was open to the objection that, after its first effects had ceased, an unpleasant after-odour was created. It also caused a serious difficulty by reason of its poisonous character both to animal and vegetable life. On the other hand, permanganic acid was harmless; it had no odour of its own to set up in place of the one destroyed; it was an instantaneous and complete deodoriser; and in doing its work was itself destroyed. Its method of action was the reverse of that of antiseptics, for it destroyed the putrescent matters presented to it. The objection that the quantity of permanganate that could be added within financial limits was only a trifling quantity of that required to oxidise the whole of the matters in the effluent was true, but it only dealt with the first stage of an oxidation scheme. The matters in an actual putrescent state were the only ones which required immediate destruction, and these were but insignificant compared with the total organic matter present. Consequently the quantity of permanganate required was only a fraction of what would be necessary for its complete destruction. Aëration had recently been put forward under the title of "oxidation." This was a misnomer. True, the ultimate object was oxidation; but if the idea was to be retained, that a very partial aëration of a strongly alkaline effluent was equivalent to complete aëration of a neutral effluent, free from actual putrescent matters, a powerful blow would be struck at the system, which, when properly carried out, was incontestably one of the utmost importance. Of the various systems of aërating large bodies of water when artificial means were necessary, there could be little doubt as to the superiority of the aquarium or "jet" system. By this means air was introduced into the water in an exceedingly fine state of division, instead of being in large bubbles, as in the "blowing" system.

The numerous patents taken out for the utilisation of sewage sludge showed that the subject was one of peculiar fascination. The idea pervading the minds of inventors seemed to be that local authorities should undertake trading operations instead of strictly confining their functions to the prevention of nuisance. Such systems might be dismissed with the observation that, if an inventor had a process by means of which he could more than repay the cost of working expenses, doubtless he would pursue the usual course adopted by business men, and, after obtaining the sludge for nothing and paying working expenses, put a handsome sum in his pocket. If the quantity of sludge were small, and suitable land available, it should be dug in; but when land was unattainable, or, even if attainable, unsuitable, other means must be adopted. The recent successful introduction of sewage sludge presses, for converting the sludge into a semi-dry portable form, at first sight appeared to be eminently suited for the purpose. Doubtless they were so under many conditions. If farmers wanted the sludge for manurial purposes, the presses were all but necessary. For small quantities they were manageable, and, as far as the subject would permit, cleanly. Strenuous efforts had been made to reduce the cost, but apparently without success. Unfortunately the hopes of sanitarians and agriculturists on this point seemed to be doomed to disappointment, and in place of the farm, in many cases the furnace appeared to be the ultimate destination of the unwholesome matter. Beyond doubt the wants of farmers should be most carefully considered. So long as they removed the sludge, so long should sufficient be pressed to meet their demands. When the quantity of sludge was small, a ready and economical method of reducing it to a portable condition was to mix it with freshly-slaked lime, as for pressing, and then to run it out on to porous beds, and allow it to rest. In a few days the sludge would have attained a consistency sufficient to enable it to be cut out with a spade and removed. By this means the water was reduced to some 70 per cent. Another good plan was that adopted at Southampton, which consisted in mixing the semi-liquid sludge with dry road sweepings, &c., in which form it was portable, and in a suitable condition for the purpose of the farmer. This system necessitated the control of the dust-bin refuse and road sweepings by the sewage authority. The recent Royal Commission recommended the application of sludge to the raising of low-lying lands, burning, digging into land, or carrying it away to sea. If land were to be raised with it, pressing must be resorted to. This involved the initial task and cost of the presses, which, coupled with the cost of transit, spreading on the land and covering with earth, made up a total so excessive as to render the consideration of other methods desirable. Before the pressed sludge could be burnt, the water must be driven off by heat. This involved expense for fuel in addition to the cost of pressing. When the dust-bin refuse of a town was available, the object could be attained by the use of "destructors." The case of the metropolitan sewage was, however, different, as no excess fuel was obtainable without considerable expense. The suggestion that the ammonia, afforded by the combustion of the nitrogenous portion of the organic matters, could be collected and sold for the reduction of a part of the expense, had been made. Calculated on 800 tons of "cake" per day, about 70,000*l.* per annum might be expected as the gross return from the sale of the sulphate of ammonia. The cost of pressing, distillation, collection of ammonia, conversion into sulphate, business charges, interest on capital, &c., deducted from this sum would be such as to lead inevitably to a financial disaster. Digging the wet sludge into the ground, as practised at Birmingham, would be a good plan in the case of the metropolis, if suitable land were available in sufficient quantity. The soil at Birmingham was mostly gravel, and suited for the purpose, whereas that in the neighbourhood of the metropolitan outfalls was heavy and sodden. Carrying the sludge away to sea thus remained the only tangible and economical system available. The cost of transit had of course to be considered. Careful estimates showed that the expense would fall far short of that which would be necessary for the preliminary process of pressing, independent of the further cost of disposing of the cake when obtained. The great advantage of this method was that the sludge would never be seen. Precipitated in covered reservoirs, transferred from the precipitating tanks to special settling tanks, from thence pumped into a vessel, and discharged under water far from land, the sludge would disappear in the most speedy, cleanly, and safe manner that could be devised. The objections to this system were: waste of valuable manure; possibility of nuisance on the coast; and delay in transit by fogs and stress of weather. If the commercial manurial value of the sludge was a fact, commercial men might be safely relied upon to utilise it. The objection as to the possibility of nuisance on the coast was a mistaken one. Some 3000 tons of "settled" sludge, equal to about 150 tons of organic matter, would be discharged daily under water several miles from the coast. The author critically examined the action which would follow, contended that no nuisance could be created, and held that the system was in accordance with both the letter and the spirit of the recommendations of the Royal Commission. The objection as to delay by fogs and stress of weather was trivial. If the whole of the enormous maritime traffic of England could be carried on with almost mathematical precision, the carriage of a few thousand tons of sewage sludge to the Channel could be as readily accomplished. While it was thus clear that in the case of the metropolis the conveyance of the sludge to sea was the only available remedy, it by no means followed that under other circumstances, and where local conditions were favourable, other systems were undesirable. Each case must be dealt with on its own merits, and according to local requirements.

Filter Presses for Sewage Sludge.

The second paper read was on "Filter Presses for the Treatment of Sewage Sludge," by Mr. William Santo Crimp, Assoc. M. Inst. C.E., F.G.S.

The author observed that in breweries, sugar factories, sewage precipitation and other works, large quantities of semi-fluids, or of fluids containing varying quantities of solid matter held in suspension, were produced, and it was often necessary to separate the solids from the liquids; this object might generally be attained by filtration, either natural or mechanical, or by evaporation. In the case of sewage works, where chemicals were the agents for precipitating the solids, difficulties had arisen from the large masses of sludge to be disposed of being in a sloppy and very offensive condition. Engineers had, therefore, endeavoured to effect a reduction in the quantity, by getting rid of as large a portion of the liquid as possible. The earliest method tried was that of exposing the sludge to the atmosphere in specially constructed filters. At Wimbledon, filters had been constructed of screened town ashes carefully underdrained, and to further aid in the desiccation of the glutinous mass, more ashes were mixed with the sludge. During the winter, however, evaporation was feeble. The author found that after exposure, between September, 1883, and March, 1884, the sludge still contained 77.5 per cent. of moisture, and was very offensive. In hot dry weather, although the sludge dried more quickly, there was much more risk of creating a nuisance, unless the material was ploughed into the ground, as at Birmingham, in its fresh condition, a method which was inapplicable in many cases. In towns of only moderate size, large areas were required for the exposure of the material, and this gave rise to a nuisance after a few days' exposure, unless the works were remote from dwellings and highways. Machines had at various times been introduced for drying sewage by the application of heat; but as sewage sludge contained in its normal condition 90 per cent. of moisture, the cost of fuel had prohibited the use of such apparatus. Milburn's drying machine, for instance, was stated to have been tried at Oldham by the Carbon Fertiliser Company, when 1 lb. of coke evaporated 6.80 lb. of water. Thus, in order to reduce 100 tons of normal sludge to 20 tons with 50 per cent. of water, about 12 tons of fuel would be required.

The paper dealt more particularly with the filter press as now adapted to this purpose. Filter presses had been employed at Wimbledon during the last two years. The present weekly production of sewage sludge, at Wimbledon, was 250 tons, and this quantity was reduced by means of two of Johnson's filter presses to 50 tons of sludge cake, containing 50 per cent. of moisture, at a cost of 2*s.* 6*d.* per ton, for labour, lime, fuel, cloths, &c., to which should be added interest on the original outlay, and depreciation, equal to 1*s.* per ton more. The precipitation of the matters held in suspension in the sewage was effected by lime and sulphate of alumina, the average quantity used daily being, for both pressing and precipitating, equal to 0.91 ton. It had been ascertained that the quantity of solids which would be produced, if the moisture were all evaporated, would be equal to 1 ton weekly for 1000 persons. In the case of the metropolis, assuming the population draining to the outfalls to be 3,800,000, the amount of pressed cake produced daily, calculated upon this basis, would be 1086 tons, or 186 tons in excess of the estimate of the Royal Commissioners on Metropolitan Sewage Discharge. The actual quantity would doubtless be less in consequence of the small quantity of lime used; but, on the other hand, the road detritus must form a considerable portion of the solids in wet weather. Taking the amount at 1000 tons daily, the annual cost of pressing would, in the opinion of the author, amount to 45,000*l.* exclusive of the charge on capital account. In consequence of the proximity of Wimbledon to the metropolis, where enormous quantities of stable manure were produced, some difficulty was experienced in selling the sludge, although the experiments of the author, which had been confirmed by Professor Munro, of the Royal College of Agriculture, Downton, proved that the pressed sludge was of more value than stable manure of good quality.

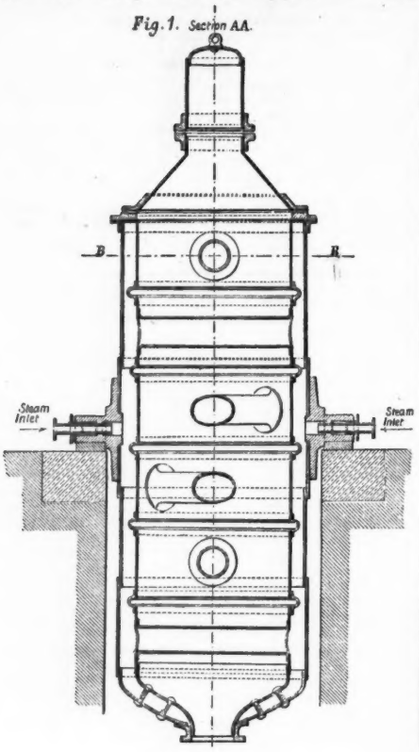
In the author's experiments sludge-cake was tried with superphosphate and with farmyard manure, the crops grown being hay, potatoes, mangolds, cabbages, and swedes, the average production per acre being in the case of sludge cake 13.15 tons, superphosphate 12.60 tons, and farmyard manure 12.27 tons, while the unmanured plot yielded 11.72 tons. Potatoes were especially benefitted by the dressing of sewage sludge.

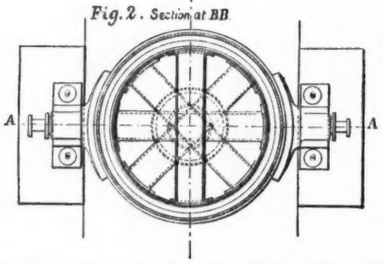
The conclusions arrived at by the author after careful observation of the filter press during the past two years were, that the machine afforded a ready solution to the question of the disposal of the sloppy mass of putrescent mud produced daily in sewage precipitation works; that the offensive and useless masses might be quickly converted into a practically inodorous manure; and that the manure was superior to ordinary farmyard manure.

Baldwin Locomotives.—The Baldwin Locomotive Works, Philadelphia, are at present extremely busy, and are working up to about their full capacity, turning out some thirteen locomotives per week, or about 650 engines per annum.

PULP BOILER.

The pulp boiler in the annexed illustration is the invention of Mr. W. Tijou, of Pinner's Hall, 15, Great Winchester-street, London. It is carried on two trunnions, through which steam pipes enter. These





pipes communicate with the steam jacket, while additional heating surface is provided by means of cross-tubes, which run through the body of pulp contained in the boiler; the introduction of these cross-tubes constitutes a departure from ordinary practice in such boilers, and affords a material increase of heating surface. In cases where the nature of the materials to be operated upon require it, the tubes are covered with lead, and the boiler is lined with the same metal.

MURDOCH'S MARINE GOVERNORS.

The annexed illustration shows a section of Murdoch's combination governor for marine engines, and for engines in which much power is required to move the throttle valve. It consists of a small governor, balanced so that the motion of the ship does not interfere in any way with the governing action, the motion of this governor being conveyed to a small valve which admits steam to a cylinder, the piston in which is connected to the throttle valve of the engines to be regulated.

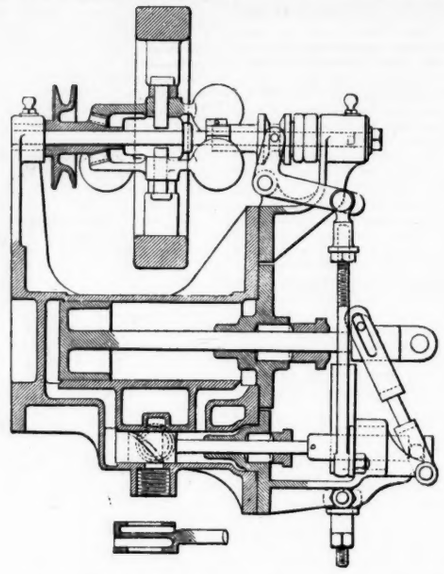
From the section it will be seen that the governor consists of a small flywheel with two weighted arms hung diametrically opposite, and gearing with a small bevel pinion cast with the driving pulley. The inertia of the flywheel and arms allows the driving pulley to overrun them on any increase of speed, and the centrifugal force of the weights keeps the position; the motion so attained is conveyed through the sleeve and levers to the valve on the steam cylinder which admits and exhausts the steam, the piston in the cylinder moving in unison with the movement of the valve. This is accomplished by attaching the piston-rod end to the end of the valve spindle by a link, so that the motion of the piston moves the small valve laterally shutting off the steam. Thus the angular motion of the valve derived from the governor, opens the steam and exhaust ports, and the motion of the piston closes the ports again, so that the motion of the piston is proportional to the angular movement of the valve.

The valve is a hollow cylinder with a longitudinal partition dividing it into two compartments, the one opening to the front and the other to the back end of the cylinder. Each compartment has a helical slot or port cut in it, so that when the valve is partly moved round, the one port opens to the steam inlet and the other to the exhaust.

The action of the engines to overrun is resisted by a spring attached to the lever which clasps the sliding sleeve, the adjustment to the speed required is done by slacking or tightening this spring. These governors have been fitted to twelve of Her Majesty's ships, and to about 400 merchant ships, and have given great satisfaction. They were shown at the Edinburgh Exhibition by Mr. John Cochrane, of Barrhead.

MURDOCH'S MARINE GOVERNOR.

CONSTRUCTED BY MR. JOHN COCHRANE, ENGINEER, BARRHEAD.



FOREIGN AND COLONIAL NOTES.

Water Conservation in New South Wales.—Some members of a Royal Commission appointed to report on the conservation of water in New South Wales recently reached Sydney from Newcastle, after having completed a tour of the northern and north-eastern districts of the colony. The party, which formed but a portion of the commissioners, left Sydney on October 11, with the view of proceeding direct to Tenterfield, where the evidence of several witnesses who were likely to be present at the railway opening demonstration was anticipated, the subsequent intention having been to proceed, *vid* Grafton, to the north-eastern coastal river districts, as the road to Inverell was at that time impassable. This programme was, as far as possible, adhered to, and after a journey of not less than 2000 miles, the Commission has temporarily, at all events, brought its labours to a close with the possession of a large amount of valuable information.

New Australian Graving Dock.—A new graving dock at Biloela is beginning to assume a finished appearance, and the contractors for the dock proper hope to have their part of the work executed by March, when their contract time will expire. The pumping machinery will then have to be erected; and if the Government pushes on this part of the work the dock will be available for use in a comparatively short time. It will be one of the largest docks in the world.

American Railroad Economy.—The Boston and Albany Railroad Company continues to build about twelve locomotives annually at its Boston and Springfield shops. No changes have been made recently in the standards, but Mr. Underhill endeavours to keep up with the best practice. Steel is more generally used, and retaining rings are employed in fastening the tyres of drivers. The automatic traction drawbar of Craven and Purvis is used on all freight engines with satisfactory results. The Martin car heater, which uses steam from the locomotives, is doing good service on a train of five coaches running between Boston and Springfield.

American Steam Shipbuilding.—The Union Iron Works, San Francisco, in addition to obtaining a contract for a new United States cruiser, have secured an order for a steel screw steamer of 1000 tons for the Canadian Pacific Navigation Company, to ply between San Francisco and Port Moody. The steamer will cost 40,000*l.* Messrs. Neafie and Levy, of Philadelphia, have taken a contract for a freight and passenger steamer for Messrs. Menendez and Co., of Havana, to ply on the Gulf Coast. The new vessel will be 245 ft. long, 35 ft. breadth of beam, and 21 ft. depth of hold. Her engines will be of the compound type, with cylinders 30 in. in diameter for high pressure and 50 in. for low pressure, with 3 ft. stroke. Steam will be supplied by two Scotch boilers, 12 ft. in diameter and 11 ft. in length, which will carry a working pressure of 100 lb. of steam. The vessel is to be completed by May 1. Messrs. Neafie and Levy are also building an iron tug-boat for service on the Delaware. She is 9 ft. long, 19 ft. beam, and 9½ ft. depth of hold. She will be supplied with a compound engine, 15 in. and 26 in., with 22 in. stroke.

Coal in the Southern States.—Coal covers an area of 5000 square miles in Tennessee, with from one to three workable seams, the best coking seam being the Sewanee, which is 500 square miles in extent. In Alabama it covers an area of 6000 square miles, embracing the Warrior, Cahawba, and Coosa fields, with three or four workable seams each from 4 ft. to 7 ft. in thickness, and mostly coking coal. Of these the Pratt seam has hitherto furnished by far the greatest amount of coal, but the good coking qualities of the other veins have been proved. The production of the Pratt mine is now 2500 tons per day, and that of the Sewanee mine, 1500 tons per day.

Russia and China.—The Russian Government proposes to construct a railway to connect Russia with China, penetrating even to the capital of the Celestial Empire. Count Ignatieff, Governor-General of Eastern Siberia, and Baron Korf, Governor-General of the Amour region, have been summoned to St. Petersburg in order to assist the Russian Government in selecting the best route. Russian engineers have projected three lines, the first running from Ekaterinburg *vid* Omsk, Semipalatinsk, Hami, Si-on-fou, Hankow, and ending at Shanghai; the second line by way of Ekaterinburg, Omsk, Irkutsk, Tchita, Hylor, Dolon, Nor, and Peking: the third line *vid* Ekaterinburg, Omsk, Irkutsk, Kiachta, Urgo, and Peking. It is stated that the Chinese Government will not oppose the construction of the contemplated line.

The Suez Canal.—The transit revenue of the Suez Canal Company amounted in December to 173,600*l.*, as compared with 197,498*l.* in December, 1885. The aggregate transit revenue collected last year was 2,261,024*l.*, as compared with 2,492,298*l.* in 1885.

Rails in Italy.—The Superior Council of Public Works has approved a contract concluded between the Minister of Public Works and the Terni Blast Furnaces, Foundries, and Steel Works Company. This contract provides for the delivery of 150,000 tons of rails to the Italian Government in the course of four years as from 1887. The rails are to be laid down upon what is known as the secondary network. They are to be delivered on trucks at Terni at 6*l.* 15s. 3d. per ton.

Belgian Steel Rails.—The exports of steel rails from Belgium in the first eleven months of last year amounted to 32,034 tons. The corresponding exports in the corresponding period of 1885 were 43,332 tons.

Northern Pacific Railroad.—Grading on the Cascade Division of this system west from Ellenbury has been completed to the summit of the Cascades. This completes one-half of the switchback over the mountains, except a stretch of 8½ miles, over which the track is not laid. The delay in track laying has been caused by the non-arrival of rails. On the west end of the division the track has been laid to Sandy Creek, 65 miles east of Tacoma.

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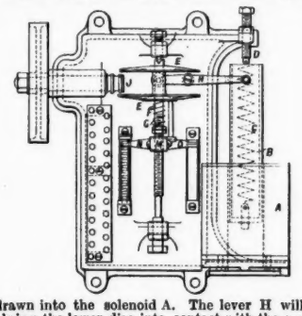
DYNAMO-ELECTRIC MACHINES.

15,484. J. Swinburne, London. Improvements in Armatures for Dynamo-Electric Machines and Motors. [8*d.* 10 *Figs.*] December 17, 1885.—In dynamos with iron armature cores, the currents in the armature wire tend to magnetise the armature in a direction at right angles to the field due to the magnets alone. This invention has for its object to lessen this action and the tendency to heating in drum armatures. This is effected by coupling the wires on the armature so as to reduce the cross magnetisation, and in the drum armature, to reduce the "Foucault currents" also, and to provide free air space. In a drum armature a group of wires are coupled together at one end and are kept separate at the other. (*Sealed January* 21, 1887).

5338. W. T. Goolden and A. P. Trotter, London, and H. W. Ravenshaw, Halifax, Yorks. Apparatus for Governing Dynamos and other Machines. [8*d.* 3 *Figs.*] April 16, 1886.—The current from the dynamo to be governed traverses a solenoid A having a core B whose weight is partly supported by the spring C which passes down its hollow centre, and is affixed at one extremity to the lower end of the core, and at the other extremity to an adjusting screw D. Part of the weight of the core is balanced by the double discs E, E, by means of the lever H. These discs are connected together, and are free to rise and fall upon the spindle F, but by means of a feather key are constrained to rotate with that spindle. A portion of the weight of the discs is borne by the spring G. When the normal current is flowing in the solenoid A, the parts stand in the position shown. Should this current experience an increase, the core B



will be drawn into the solenoid A. The lever H will be tilted, and will bring the lower disc into contact with the constantly rotating pulley J, thereby setting the disc in motion. On the current decreasing, the core will rise until the upper disc rests on the friction pulley. The disc will then rotate, but in the opposite direction to that when the lower disc touched the pulley. The motion of the discs E, E, is transmitted to the spindle F. This spindle is screwed at its lower part, and carries a nut M which is prevented from rotating, and is provided with two arms N, O, which slide over electrical contact-pieces. The piece under O is plain, but that under N is formed of the terminals of a set of resistances. The current flows from O to N or *vice versâ*, and according to the position of the latter more or less resistance is included in the circuit of which O N forms a part. (*Accepted December* 10, 1886).

ELECTRIC LIGHTING.

1096. B. J. B. Mills, London. (*L. Stieringer, New York, U.S.A.*) **Improvements in Incandescing Electric Lamps and in the Arrangement thereof.** [8*d.* 3 *Figs.*] January 25, 1886.—According to this invention the glass stem through which the leading-in wires pass, is filled with asbestos fibre or other suitable refractory insulating material, with the object of preventing the formation of the arc when the carbon filament breaks. (*Accepted December* 14, 1886).

1193. O. E. Woodhouse and F. L. Rawson, London. Improvements in Incandescent Electric Lamps. [8*d.* 7 *Figs.*] January 26, 1886.—The improvements consist in constructing incandescent lamps with two or more separate filaments of different candle-power placed in one globe, or combined in action, but in separate globes, so that a filament of smaller candle-power is available for use if the longer filament should be destroyed, or when only a little light is required. By the introduction of a resistance various modifications of circuit in parallel or series through the two or more filaments enable various modifications of lighting effect to be obtained by the use of switches. (*Accepted January* 5, 1887).

9042. W. R. Lake, London. (*A. Zanni, Modena, Italy.*) **Improvements in Electric Incandescence Lamps and in the Manufacture of Illuminating Conductors therefor.** [8*d.* 6 *Figs.*] July 10, 1886.—According to this invention two or more carbon rods are used instead of the looped filament ordinarily employed. These rods are connected at one end with platinum wire or other metal conductors which are passed through and sealed in one end of the lamp globe or bulb for connection with the line or circuit. The rods are connected at the other end by one or more metal bars or pieces of wire to complete the circuit through the carbon rods. The bars, wires, or other conductors may be steadied by means of pieces of glass connected with the lamp globe. The illuminating conductors are manufactured by first forcing carbon paste through a perforated plate and cutting the rods thus produced into pieces of the required length, then drying the pieces and subjecting them to a white heat in a crucible or retort, and then heating them in a solution of chloride of platinum, calcium or iridium, to fill up the pores, and then again drying them. (*Sealed January* 18, 1887).

11,694. H. H. Lake, London. (*J. I. Clapp, Boston, Mass., U.S.A.*) **Improvements in Electric Lamps or Lighting Apparatus.** [8*d.* 9 *Figs.*] September 14, 1886.—This invention relates to electric lamps in which the arc is maintained between the peripheries of two discs composed of carbon or other suitable material. The improvements relate to the means employed for separating the discs in order to establish the arc, and for subsequently rotating the discs in proportion as they burn away at their edges. The discs *a*, *a*¹ are mounted on shafts *b*, *b*¹ having bearings in frames *c*, *c*¹, pivotted at *c*². The shafts are connected by a train of gearing so proportioned that one shaft turns with double the speed of the other, corresponding to the rate of combustion of the discs when the current traverses the arc

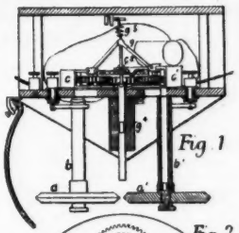


Fig. 1

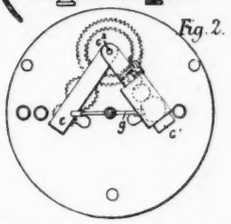
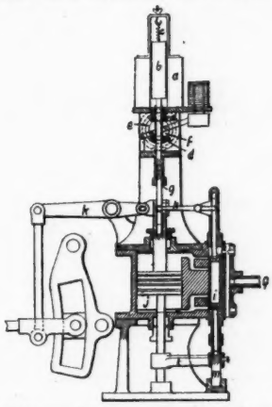


Fig. 2.

continuously in the same direction. A toggle lever *g* has its ends connected to the frames *c*, *c*¹, and its joint connected by a link with the movable armature or core of the electro-magnet *g*⁴, which is included in the main circuit with the arc, and is provided with a spring *g*⁵ acting on the toggle lever with a tendency to draw the frames *c*, *c*¹ together, so that the discs are normally in contact, when no current is flowing, as is required for the establishment of the arc. When the current begins to flow, the magnet *g*⁴ is energised, causing it to attract its armature and through the toggle lever *g* to separate the discs until the attractive force of the magnet is brought by the increased resistance of the arc into equilibrium with its retracting spring *g*⁵, which takes place when the arc is of normal length. (*Accepted November* 26, 1886).

REGULATING, MEASURING, &c.

12,096. C. J. Bosanquet, Spilsby, W. Cameron, Lincoln, and W. A. Tomlinson, Folkingham. Appliances for Regulating the Current or Electromotive Force of Electric Currents and the Speed of Motors. [8*d.* 7 *Figs.*] October 12, 1885.—When the electromotive force is at its mean, the core *b* of the solenoid *a* is maintained in such a position by the spring *c* pulling against the current in the solenoid coils, that the wheels *d*, *d*¹ are not in contact with the driving wheel *e*. If a greater or less amount of current pass through the coils of the solenoid *a*, the downward or upward



movement of the core *b* puts the upper or the lower wheel into gear with the wheel *e*, rotating sleeve *f* in one or the other direction, and by means of the screwed spindle *g*, and the lever *h*, actuating the valve *i* so as to operate the piston *j* of the auxiliary cylinder, the movement of which is transmitted by the lever *k* to the regulating apparatus of the motor. The movement of the piston *j* gives at the same time a twisting movement in opposition to the gear wheels to the valve *i* by means of an arm *l* which slides in an oblique groove in the sleeve *m*. Fluid enters through a pipe Q to the ends of the valve *i*. (*Sealed December* 3, 1886).

14,212. A. Millar, Glasgow. Magnetometer. [8*d.* 2 *Figs.*] November 20, 1885.—The purpose of this instrument is to measure the magnetic intensity of magnets and electro-magnets. A brass tube B is enabled to slide within a brass tube A by means of the rack R and pinion P. The inner tube B has a cover C in which works an adjusting screw D. The lower end of the screw carries a spiral spring of brass or other non-magnetic metal, to which is attached a light soft iron armature F. An opening is made in the front of the tubes A, B, so as to allow the upper half of the armature to be readily seen. When the armature F is in its normal position, a reading line or mark cut on its surface should be exactly opposite the line on the surfaces H of the outer tube A. In using the instrument, it is placed with its base J resting on the pole of the magnet to be measured; the attractive force of the magnet will draw the armature downwards against the pull of the spiral spring. The tube B which carries the spiral spring is then raised by turning the pinion P until the upward pull of the spring is just sufficient to bring the armature back to its normal position. The distance which the spring has to be stretched,

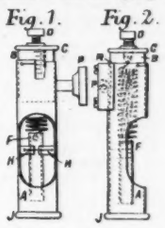


Fig. 1. Fig. 2.

that is, the distance which the tube B has to be raised, as shown on the graduated scale, to produce the equilibrium of the magnet and spring, is the measure of the attractive force of the magnet upon the armature F. (*Sealed November* 26, 1886).

TELEGRAPHY AND TELEPHONY.

668. F. H. W. Higgins, London. Improvements in Electric Telegraph Printing Receiving Instruments. [1*s.* 1*d.* 9 *Figs.*] January 15, 1886.—The improved receiving instrument consists of a clock train actuated by a weight so as to rotate a pair of type wheels. The escapement wheel and anchor have stop surfaces meeting approximately radially to the centre of the escapement wheel. The apparatus actuating the escapement consists of the divided armature polarised through its pivot pieces by a permanent magnet, and is situated between the pole-pieces of a compound electro-magnet. The type wheels are formed from polygon wheels with flat faces by engraving or cutting the required letter or character on each flat surface. The mechanism for shifting the type wheels along their axes to bring one or the other of them into use consists of a part carried on the printing lever and engaging with the type wheels, and which part, when the printing lever is raised, is moved by being brought against projections rotating with the type wheels. The paper is advanced by means of a driving pawl mounted on a lever actuated by the printing lever and a retaining pawl and lip or flange. This printing receiving instrument is combined with gear by means of which the maintaining power is continued in operation and the working of the instrument is not interfered with whilst winding. (*Sealed January* 21, 1887).

9053. E. S. Spaulding, New York, U.S.A. Electrically Reproducing Articulate Sounds. [8*d.* 3 *Figs.*] July 12, 1886.—The novelty of this invention relates to the method of reproducing the human voice through the medium of crepitations or minute crackling sounds or detonations, and the novelty particularly consists in causing the original disturbances in the transmitter to be transmitted over the line so as to affect the receiver. A is an ordinary transmitter, B the battery, C the line, and G the ground. H, Fig. 1, illustrates the simplest form of the improved receiver or "krotophone" in which D, D¹, are the carbon pencils which form part of the line C, one of the pencils D being rigidly secured in the receiver, whilst the other pencil D¹ is adjustably secured therein by means of a screw F. Any disturbance of the point of contact of the carbon points of the transmitter will cause a series of electrical impulses to be trans-

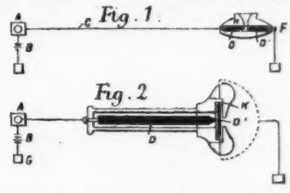


Fig. 1.

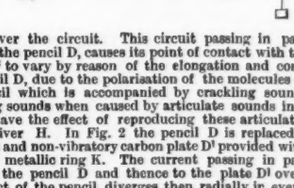
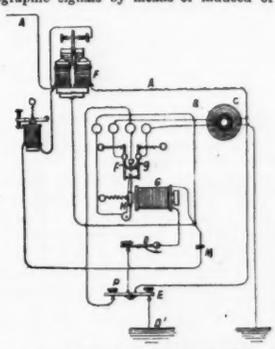


Fig. 2

mitted over the circuit. This circuit passing in parallel lines through the pencil D, causes its point of contact with the opposite pencil D¹ to vary by reason of the elongation and contraction of the pencil D, due to the polarisation of the molecules or atoms of the pencil which is accompanied by crackling sounds. These crackling sounds when caused by articulate sounds in the transmitter, have the effect of reproducing these articulate sounds in the receiver H. In Fig. 2 the pencil D is replaced by a non-sonorous and non-vibratory carbon plate D¹ provided with a circumferential metallic ring K. The current passing in parallel lines through the pencil D and thence to the plate D¹ over the point of contact of the pencil, diverges then radially in every direction towards the metallic ring and thence to the ground. This construction gives an amplified sound, and this result may be attributed to the radial or diverging paths of the current. (*Sealed November* 30, 1886).

11,693. H. H. Lake, London. (*M. G. Farmer, New York, U.S.A.*) **Improvements in Telegraphic Apparatus.** [8*d.* 1 *Fig.*] September 14, 1886.—The improvements consist in a novel arrangement of circuits for sending and receiving telegraphic signals by means of induced or secondary



currents. A is the main or signalling line extending between two or more sections, B is the primary of the induction coil at one of the stations, and C the secondary of the same. The main circuit branches at the induction coil, one branch including the secondary

and going to ground at D; the other branch leading to a switch key E with a contact plate grounded at D¹. In the main line is a polarised relay F. In order to transmit signals by means of the key O, the switch key E is opened so that the line or main circuit is grounded through the secondary of the induction coil. The switch key P, on the other hand, is closed so as to bring the contacts *f*, *g*, into connection with the battery M. The key O is then operated to make and break the circuit through the magnet G. On closing the branch including this magnet, the armature H is attracted towards the magnet, and a current sent through the primary of the induction coil. This induces a current on the line which operates the polarised relays at the sending and receiving stations. On raising the key O, the circuit through the magnet G is interrupted, a current impulse of opposite direction to the first is sent through the primary of the induction coil by the reaction of the armature H, and the relay armatures are shifted to their original position. When not sending by the key O, the operator closes the key E so as to short-circuit the primary of the induction coil, and opens the key P, current impulses coming on the line operate the polarised relay and the receiving instrument in the usual way. (*Sealed December* 28, 1886).

13,312. J. H. Linville, Philadelphia, Penn., U.S.A. Improvements in Printing Telegraphs. [2*s.* 4*d.* 24 *Figs.*] October 19, 1886.—The invention relates to a printing telegraph system and apparatus of the class in which rotating type wheels controlled by escapements are used in connection with printing apparatus operated by electro-magnetic devices. The object of this invention is to print telegraphically messages, stock reports, &c., in page form on sheets of paper, or upon continuous rolls of paper in lines, paragraphs or columns, similar in form and arrangement on the transmitting instrument simultaneously with their transmission to a receiving instrument. The improvements consist chiefly in controlling the movement of the type wheels by escapements on one type wheel shaft with escape wheels actuated by a train of gearing moved by an electromotor; in electrical mechanism for closing the printing circuit consisting of a novel construction of a compound relay with compound armatures linked to a relay tongue, the armatures vibrating when currents are sent alternately through the respective branches of the electro-magnets, and the relay tongue operating only when the circuits are closed simultaneously through both electro-magnets; also in mechanism for holding the paper, and consisting of a paper carriage traversing backward and forward on and over a platform in the rear of the transmitting and receiving instruments. A unison device operating either separately or in conjunction with a locking device, is released by a compound or duplex relay that closes the printing and paper-feeding circuits. This improved telegraphic printing instrument may be operated interchangeably as a transmitter or as a receiver, the change from a combined transmitting instrument to a receiving instrument being readily accomplished through the manipulation of a switch, without auxiliary gearing or motive power. (*Accepted November* 19, 1886).

BATTERIES AND ACCUMULATORS.

13,422. W. A. Barlow, London. (*M. Sappey, Paris.*) **A New Galvanic Battery with Apparatus for Automatically Supplying Liquids thereto.** [1*s.* 1*d.* 23 *Figs.*] November 5, 1885.—This invention relates to an electric generator composed of a group of cells forming an independent battery or series of batteries of the two-liquid class having zinc and carbon electrodes, the zincs being placed in porous vessels. The novelty consists essentially in a syphon arrangement which is actuated by the current from the generator for automatically effecting a regular circulation and renewal of the liquids. (*Sealed January* 7, 1887).

335. D. G. Fitz-Gerald, London. Improvements in Voltaic Batteries. [8*d.* 4 *Figs.*] January 8, 1886.—The improvements relate to the manufacture of peroxide of lead elements for voltaic batteries. A hydrated compound of oxide of lead and glycerine is produced by making the lead oxide into a paste with a fluid composed of glycerine in admixture either with water, or a saline solution, or with a dilute acid. A compound structure to be converted into a peroxide of lead element, consists of a superficially peroxidised core or support of a compound of oxide of lead and glycerine, coated with an external layer of a more porous and readily convertible oxide of lead composition, in combination with a strip of platinum in contact both with the peroxidised surface of the core and with the external layer. (*Sealed January* 14, 1887).

1054. J. H. Noad, Upton, Essex, and R. Matthews, London. An Improved Construction or Formation of Plates with Composition for Electric Batteries. [4*d.*] January 23, 1886.—The plates consist of woven or meshed copper wire coated with a paste composed of oxide of lead or litharge and glycerine. The plate thus coated is then baked in an oven at a temperature of about 300 deg. Fahr. to thoroughly oxidise the glycerine, forming an insoluble compound, and constituting one of the plates of an electric battery. (*Accepted November* 23, 1886).

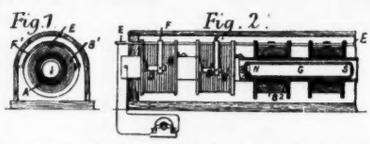
10,536. E. D. Kendall, Brooklyn, U.S.A. A New and Useful Composition of Matter to be Used as an Electric Battery Excitant. [4*d.*] August 17, 1886.—The improved composition consists of a mixture of potassium bichromate and sulphuric acid, which, while still warm and semi-fluid, may be poured into suitable moulds to form rods, cakes, &c., and allowed to cool and solidify. The material thus produced in the form of lumps, cakes, powder, or other desired form, is then ready to be used in any battery to which it is adapted, by simply dissolving it in water, and pouring the solution into the cell, or by putting the compound into the cell and filling the latter with water in which the compound freely and rapidly dissolves. (*Sealed December* 28, 1886).

10,644. A. Millar, Glasgow, N.B. Improvements in Electrodes for Secondary Batteries. [4*d.*] August 20, 1886.—According to this invention electrodes for secondary batteries are made by soldering together at their ends a number of strips of metal which are either singly or in sets of two, three, or more, enveloped with a fibrous and somewhat elastic material. The object of the fibrous elastic envelope is to maintain the "active matter" of the electrode in close contact with the metal strips, especially when the battery is subjected to shaking or jolting. (*Sealed November* 26, 1886).

11,823. P. Bailly, Ermont, France. Improvements in Primary and Secondary Batteries. [8*d.* 8 *Figs.*] September 17, 1886.—This invention relates to the special arrangement of a single conductor formed out of the lead plate of the electrode for the purpose of making the connection with the external circuit so as to dispense with joints; to the manufacture of electrodes from zinc by the amalgamation of fine particles and subsequently moulding the amalgam otherwise than by fusion; and to the manufacture of receptacles for batteries by placing one vessel inside another and separating them by some material insensible to the action of the acids employed. (*Sealed December* 24, 1886).

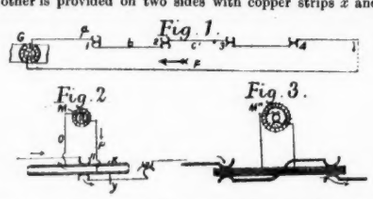
ELECTRIC LOCOMOTION.

7003. A. H. Reed, London. (*J. T. Williams, Mount Vernon, New York, U.S.A.*) **Electro-Magnetic Transmitter or Conveyance.** [8*d.* 9 *Figs.*] May 25, 1886.—Upon a tube A of brass or other suitable non-magnetic substance are mounted at intervals a series of helices B, B¹, B², &c., wound upon spools of wood or other non-conductor of electricity. One end of the wire from each helix is brazed or otherwise metallically connected to the tube A, whilst the other end of each helix is connected respectively to a contact piece D, D¹, &c. Through the flanges of the spools containing the helices B, extends an electric conductor E which is insulated from the tube A and from the helices, and on this conductor are mounted a series of horseshoe magnets F, F¹, &c., so as to embrace the helices B, B¹ respectively. The tube A is connected by a wire with one pole of a dynamo H, and the conductor E is connected by another wire with the opposite pole. When the permanent magnet or carriage G to which



motion is to be imparted is introduced into the tube A, the north pole of the magnet F becomes attracted by the south pole of the carriage G, and swings into contact with the contact-piece D. The circuit is thus closed through the helix B, and the carriage G is moved forward in the tube by the axial magnetism. As soon as the south pole of the carriage comes opposite to the north pole of the magnet F¹, the helix B' is vitalised, and a fresh impulse is imparted to the carriage, and so on by every helix through which the carriage passes. Whenever the centre or neutral point of the carriage passes the north pole of one of the magnets F, the contact previously made between that magnet and the corresponding helix is broken and the vitalisation of this helix stops. (*Sealed November* 19, 1886).

11,099. P. M. Justice, London. (*The United States Electric Company, Denver, Colorado, U.S.A.*) **Improvements in Electric Railways.** [8*d.* 8 *Figs.*] August 31, 1886.—The main object of this invention is to dispense with bare conductors. Fig. 1 is a diagram showing the conductor for a single line of road with the return wire F and generator G in circuit. The wire is cut up into insulated sections *a*, *b*, *c*, *d*, of convenient length, connected together by circuit-closing devices 1, 2, 3, 4, which are represented simply as two metallic springs attached to the ends of the sections. When left to themselves the springs come automatically into contact, and thus close the circuit through two adjacent sections. If, however, some insulating material is pushed between the springs, the circuit will be broken and the current can no longer pass; but if the insulating body is withdrawn, they will of themselves close the circuit. Fig. 2 shows the manner of putting into circuit on the single line a translating motor or electric receptive device M. An insulating body in the form of a bar sufficiently long to reach from one circuit closer to the other is provided on two sides with copper strips *x* and *y*,



connected by wires *o*, *p*, with the motor M which is carried on the car or locomotive. When this bar is pushed between two of the springs, as shown at 11, the current will flow from the section *a*, through the spring connected at 11, into the metallic strip *x*, up through the wire *o* attached to it, thence through the motor M, back through the wire *p* to the strip *y*, thence to the spring on the end of section *b*, and through *b*. If the insulating bar be withdrawn from between the springs at 11, they immediately close, and the circuit is complete. Just before one end comes from between two of the springs, the other end will have entered between the pair of springs of the next circuit closer, and the foregoing is repeated at this and each successive circuit closer. Fig. 3 is a diagram illustrating an arrangement of the conducting strips *x*, *y* on the insulating bar for preventing short-circuiting. Danger to life is greatly diminished, as the circuit closers are the only places at which persons can get into contact with the insulated conductors. (*Sealed December* 24, 1886).

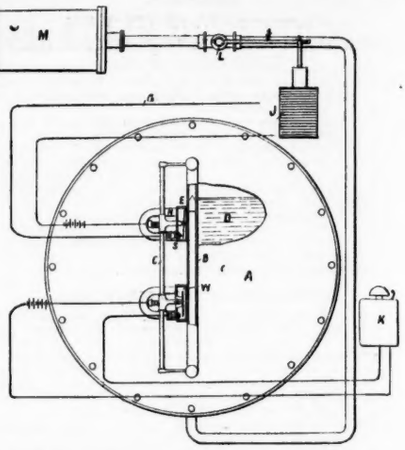
CONDUCTORS, INSULATORS, &c.

1034. G. Sutton and W. T. Henley's Telegraph Works Company, London. Improvements in Electric and other Cables and Ropes. [8*d.* 4 *Figs.*] January 23, 1886.—According to this invention the insulated conductors or cores are covered with a braiding or plaiting of more or less fine metallic wires. In the case of large cables or ropes an alternate or other series of layers of material and braided or plaited wires may be employed. In all cases an external covering of lead may be put on and insulated by any suitable substance from the last metallic covering. For ships' rigging, mining, or other purposes an ordinary core of hemp or wire is employed instead of the conductor and the insulating compound. (*Sealed January* 25, 1887).

1192. O. E. Woodhouse and F. L. Rawson, London. Improvements in Insulating Stands. [8*d.* 3 *Figs.*] January 26, 1886.—The improved construction of insulating stands has the object of preventing dust and dirt from spreading over the surface of the paraffin, oil, or other insulating substance or liquid that may be used to prevent short-circuiting. A stem springing from the centre of the cup containing the insulating substance, supports an overhead cap which overhangs the outer edge of the cup and prevents any impurities collecting on the surface of the oil contained in the cup. (*Accepted November* 26, 1886).

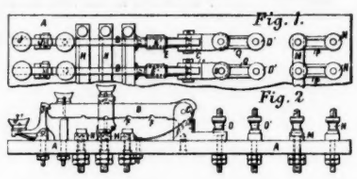
MISCELLANEOUS.

10,508. J. J. Ghegan, Newark, New Jersey, U.S.A. Automatic Electric Liquid Level Indicator and Controller. [8*d.* 7 *Figs.*] August 17, 1886.—A is a steam boiler with the ordinary glass water gauge tube B. C is one of the usual guard rods of the water gauge. E is a float of magnetic material adapted to rise and fall with the liquid within the tube. A pivotted armature and a magnet N S are placed in such relative position to each other and to the tube B, so that when, by change of level of the liquid in the tube B, the float E approaches one of the poles N, S of the magnet, the magnetic field is disturbed so as to deflect the armature and cause it to make contact with suitably arranged contact-pieces. When the circuit G becomes closed the electro-magnet J opens the valve L, and the pump M thereupon operates and forces water into the boiler A, which will cause the float to rise and recede from the pole N of the magnet N S, whereupon the armature will assume its normal position, and thereby open the circuit G, thus closing the valve L and



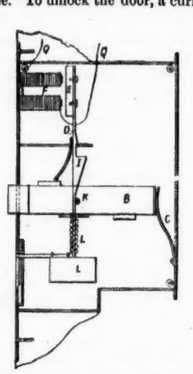
shutting off the water. If a simple alarm for lower water is desired a circuit containing an alarm bell K is connected to the circuit-closer as shown at W. (*Sealed November* 23, 1886).

13,478. R. A. Scott, W. T. Goolden, and A. P. Trotter, London. Electrical Switch-Boards or Apparatus for Connecting Sources of Electricity, such as Dynamos, with Electrical Circuits. [8*d.* 2 *Figs.*] November 6, 1885.—The base board A is formed of timber, slate, or other non-conducting material, and upon it are mounted a number of arms B, B, each of which forms one terminal of an electric circuit. Each arm B is pivotted in a bracket C provided with a terminal D. A sliding piece E may be moved backwards and forwards upon the arm B by means of a non-conducting handle E¹. The lower part of the slider E is provided with a contact piece for making good contact with the dynamo bar H below it. The



other terminals of the dynamos are all connected to the bar M. The circuits commence at the terminals D, D, and pass through safety fuses O to the terminals D¹ D¹, from which they branch off. At their other extremities they come to the terminals N, N, and pass through safety fuses P to the dynamo bar M. The arm B is constantly pressed by a spring I which has a tendency to throw the arm upwards as soon as the catch J is released by pressure on the insulated knob J¹. When contact is to be made between one of the circuits and one of the dynamos, the corresponding slider E is adjusted to the proper notch on the underside of the arm B, and the arm B is pressed down until caught by the catch J. (*Sealed November* 5, 1886).

14,695. C. L. Carson, London. Electrical Apparatus for Releasing Door and similar Fastenings. [8*d.* 3 *Figs.*] November 30, 1885.—This invention has for its object the releasing of the bolts of doors of theatres and other public buildings from a distance by a weak current of electricity. The door being shut, and the rod D raised as in the figure, the latch B is shot out by the action of the spring C. The door is now fast, but it can be opened by hand by pulling back the latch B by means of a knob or otherwise. To unlock the door, a current is sent from



the manager's office through wires Q to the electro-magnet F which then attracts the armature E, drawing the upper part of D towards it and releasing the catch G from the support H. The force of the spring or weight L immediately draws down D, bringing the incline I into contact with the projection K and so pushing back the latch B. (*Sealed December* 17, 1886).

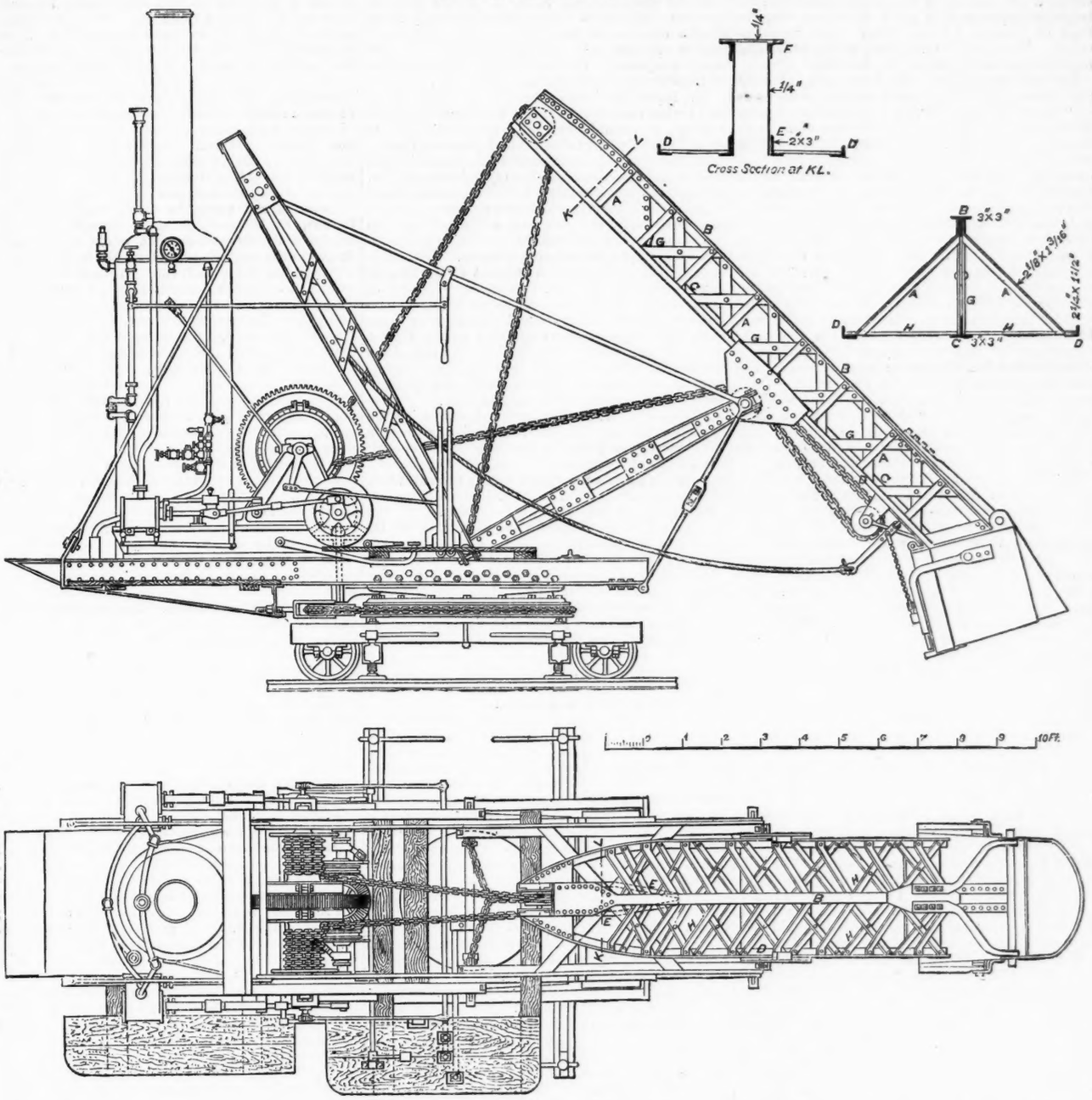
UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford street, Strand.

STEAM EXCAVATOR.

CONSTRUCTED BY THE OSGOOD DREDGE COMPANY, ALBANY, N.Y., U.S.A.

(*For Description, see Page* 128.)



THE INSTITUTION OF MECHANICAL ENGINEERS.

As announced in our last issue, the annual spring meeting of the Institution of Mechanical Engineers was held on the Thursday and Friday evenings of last week, the 3rd and 4th insts. The preliminary proceedings, during which the new President, Mr. E. H. Carbutt, was installed, have already been referred to in our previous notice, and we may therefore at once proceed to deal with the more substantial business of the meeting.

Triple-Expansion Marine Engines.

The adjourned discussion on the late Mr. Robert Wyllie's paper on "Triple Expansion Marine Engines" was the first item on the programme. This paper, with the illustrations accompanying it, has already been printed in full in these columns,* but it will be as well, perhaps, for us to give a brief abstract of what was said at the Leeds meeting after the reading of the paper.

On that occasion Mr. D. B. Morrison, who has succeeded Mr. Wyllie at Messrs. Richardsons', said it had been the author's wish to touch upon as many as possible of the numerous points bearing directly on the efficiency of triple-expansion engines. In taking indicator diagrams simultaneously from the three cylinders, the greatest care was required with that from the high-pressure cylinder, owing to the sticking of the indicator piston at the top of the stroke. The Stella was at that time making her second voyage. With artificial draught she averaged 8½ knots, burning 14 tons of inferior coal daily. The advantage of artificial draught lay in getting higher evaporative duty from good coal, not in utilising inferior fuel. Corrugated flues had been used for the boilers of thirty triple-expansion engines and had given no trouble.

Mr. William Parker said that the triple-expansion engine was the engine of the future, and the compound engine might be regarded as obsolete. Forced combustion was the most likely direction in which the next advance would be made. Four cylinders working tandem upon two cranks with triple-expansion appeared to be superior to three cylinders arranged fore and aft on three cranks. The intermediate and low-pressure cylinders should be steam-jacketted. The best ratios for the three-cylinder capacities were 1, 2½, 7½, cutting off in each at 60 per cent. The weight and momentum of the moving parts should be included in calculating the twisting moments on the crankshaft. In this connection there was a slight difference in

* See ENGINEERING, vol. xlii., pages 470 and 494.

favour of three cranks. The alteration of engines to triple-expansion in one of the largest mail companies had saved fuel so that a dividend had been made.

Mr. Charles Cochrane urged the importance of completely separating the boiler duty from the engine duty. From the wire-drawing shown in the indicator diagrams, with ports of known size, the limit of velocity for the steam might be ascertained. This should not exceed 40 ft. per second for full expansion without wire-drawing.

Professor Alexander B. W. Kennedy pointed out that three-cylinder engines are entitled to the name of "compound" as much as two-cylinder engines. He also would be glad to know the size of ports in the engine described. There were, he said, not as yet any exact experiments as to marine engine economy. The quantity and temperature of the feed water ought to be considered. Steam consumption from indicator diagrams was always too small; and the diagrams illustrating the paper corresponded to higher evaporative duties than were possible from ordinary coal. The advantage of triple-expansion lay in the higher boiler pressure and greater expansion which were practically utilised in the three cylinders. Instead of the low-pressure cylinder being the source of the greatest inefficiency, he considered the unruly member was the high-pressure cylinder, in which occurred the initial condensation that constituted the most serious of the remediable causes of loss. In the combined indicator diagrams now exhibited, the different clearances were properly shown for the several cylinders, thereby enabling the successive diagrams to fall rightly into their relative places, and to compare correctly with the theoretical expansion curve.

Mr. Thomas Mudd thought the three equalities enumerated in the paper, did not constitute the most important conditions of efficiency. There were two classes of conditions, those affecting the steam, and those affecting the mechanism; the former were those dealt with by the author. The true test of steam efficiency was the area or mean effective pressure of the indicator diagrams. The speaker then enumerated the principal sources of loss in steam efficiency as follows: (1) Excess of condensation over re-evaporation; (2) drop of pressure in receivers; (3) waste in exhaust; (4) general radiation; and (5) clearance space, particularly in the low-pressure cylinder. Diagrams were shown taken from the triple engines of the Abeona when steaming 9½ knots, burning 12¼ tons per day, and developing 800 indicated horse-power or 1.43 lb. per indicated horse-power per hour with equal horse-power in the three cylinders. The speaker pointed out that for the theoretical expansion curve so much only of the clearance space should be taken as had to be filled with steam after compression. The sequence of cranks recommended in the paper was high, low, intermediate; commonly known as low-pressure leading. This admitted of smaller receivers than with the high-pressure crank leading, that is the ordinary sequence high, intermediate, low. In the latter the three events, admission to the following cylinder, compression in one end, and release from the other end of the exhausting cylinder, were nearly simultaneous. The consequent advantage of the ordinary sequence might be appreciated by considering that oblique dividing lines between the successive indicator diagrams from the three cylinders of a triple engine were preferable to horizontal lines of division; and this conclusion was confirmed by the greater economy obtained from engines with the high-pressure crank leading than from similar engines with the low-pressure leading. Three causes contributing to this result were, firstly, the prevention of loss from a sudden fall of temperature in the released steam exhausting into the receiver; secondly, that the following cylinder was saved from part of the bad effect of internal condensation; and, thirdly, that the turning forces were found to be much more equable. The speaker had for these reasons abandoned the arrangement with the low-pressure crank leading. An advantage arose, the speaker thought, from allowing the three separate ranges of temperature in the successive cylinders to overlap one another, instead of forming the minimum subdivision of the total range; and the range in the low-pressure cylinder might be considerably greater than in either of the other two. Equality of initial stresses affected the strength of parts and the extent of bearing surfaces, and the equality of horse-powers influenced the ease and regularity of turning. If one cylinder only was to be steam-jacketted it should be the low-pressure; but the beneficial effect of steam-jacketting had become so diminished in triple-expansion engines that in them he had left off the jackets altogether. With three cranks and high boiler pressure a good proportion for the cylinder diameters was 3, 5, 8. Steam passages must be designed to reduce wire-drawing. Three cranks were better than two, and a three-crank engine occupied only the same length as a two-crank compound. He had adopted a modification of Hackworth's single eccentric valve gear.

Mr. Daniel Adamson thought that boiler pressures still higher than 150 lb. might be adopted with advantage, and would result in quadruple engines. By steam-jacketting with steam at high pressure, the low pressure expanded steam could be increased in bulk half as much again in passing from cylinder to cylinder. He had advocated making boiler flues in sectional lengths. With increase of steam pressure temperature rose slowly, but iron increased in strength up to a temperature considerably above that corresponding with the pressure at present in use. With multiple cylinders there was a prospect of working at 200 lb. pressure at least. With equal ranges of temperature in the successive cylinders it was impracticable to obtain equal horse-power from each. The high-pressure cylinder exerting least power should work on a crankpin on the end of the screw shaft; the middle cylinder should come next, and the low-pressure cylinder with the greatest power should be furthest along the shaft.

Professor R. H. Smith suggested comparing the indicated horse-power of the engine with the mechanical horse-power of the boiler instead of with the weight of water evaporated. Multiplying the pressure in pounds per square foot by the cubic feet of steam generated per minute, and dividing the product by 33,000, the quotient would be the mechanical horse-power of the boiler. Mr. H. H. West said that equality in range of temperature in each cylinder should be qualified by consideration of the length of that portion of the stroke through which the range extended. Mr. David Greig advocated having trials made with compound engines worked at the same pressure as triple expansion, and considered that the question of priming should not be lost sight of. He worked with 200 lb. pressure without trouble, and doubtless it would be reached with marine engines, when four or possibly five cylinders would be required.

Upon the resumption of the discussion at the meeting last week much of the old ground was gone over again. The walls of the theatre were covered with drawings, mostly of indicator diagrams. These no doubt will prove highly instructive to the members when they all come to be accurately delineated in the Transactions of the Institution. We noticed one member of the audience industriously sketching these graphic records in his note-book; but, although we look on free-hand drawing as an elegant and useful accomplishment, we do not consider it altogether a suitable medium for reproducing indicator diagrams (although we are told that the best originals may be obtained in this manner), and we must therefore refer our readers to the forthcoming official volume for this feature of the proceedings.

Mr. D. B. Morrison was the first speaker upon the discussion being resumed. He said that the three-crank triple-expansion engines were economical from a wear-and-tear point of view, as the turning moment was more uniform, so that owners were discarding two-crank tandems and taking to three-crank triples. He thought the quadruple-expansion engine with 170 lb. of steam would be used in the future. There was evidently a great difference of opinion on the question of ratio of expansion in the different cylinders, but in this matter it was necessary to bear in mind the different practical considerations by which the work would be influenced; for instance, in a land engine a terminal pressure of 7 lb. absolute might be advisable, but in the necessarily lighter machinery of a man-of-war 12 lb. would be the lowest limit to give the best result. The speaker next referred to a diagram of twisting moments which had been placed on the wall. He invited Professor Kennedy —who, as stated in our last issue, is in charge of the experiments to be made by the Research Committee of the Institution, which is to inquire into the subject of marine engine trials—to take a trip in one of his firm's steamers, say, from Hartlepool to Plymouth. He would promise him every facility for collecting data, excepting that he could not undertake to measure feed water. The speaker then referred to some of the experiments quoted in the paper, and to Professor Kennedy's criticisms upon them. He thought the latter had failed to grasp the full meaning of his, the speaker's, figures, and endeavoured to make his meaning clear by means of diagrams on the black-board, but, unfortunately, did not quite succeed in his object; so far at least as Professor Kennedy and Sir Thomas Hawksley were concerned, the latter, who was sitting at the President's, table, having a small private controversy with the speaker which was not audible in the body of the theatre. Mr. Morrison next referred to the question of sequence of cranks, again using the black-board to illustrate his remarks. Messrs. Richardson, the speaker stated, were fitting steamers with appliances for artificial draught, and would be glad to hear the opinion of engineers on this point, more especially as to whether it would be detrimental to boilers. It was, he believed, generally thought that the results of using forced draught would not be conducive to the long life of boilers, but in the Stella, where it had been used, they had not found any bad effects. In another ship they had reduced the consumption from 22 tons to 18 tons by artificial draught, whilst in a sister vessel, in which natural draught was used, 24 tons were still burnt. He thought 12 to 15 per cent. advantage might be obtained by artificial draught.

At this point the secretary read a letter from Mr. A. C. Kirk, who was not present. The compound engines of Mr. Elder's time were, Mr. Kirk said, a great step in marine engineering. They were Woolf engines with four cylinders, the steam first expanding in the high-pressure cylinders, and then simultaneously in the high and low-pressure cylinders. This had the great defect that the high-pressure cylinder worked through the full range of temperature from that of the admission to that of the exhaust opening to the condenser. Thus it was less, however, than in the single cylinder in which the range of temperature was from that of the boiler to that of the condenser, and this was its advantage. The next step was in the introduction of the receiver, and the cranks at right angles, the high-pressure cylinder over one crank and the low-presure over the other. For this improvement we are indebted, Mr. Kirk thought, to Mr. E. A. Cowper. The high-pressure cylinder then worked through a range of temperature from that of the boiler to the initial temperature of the low-pressure cylinder. Thus the range of temperature was much more equally divided between the cylinders. As the construction of boilers and the confidence of owners increased, steam pressures were gradually raised, till, if by expansion full advantage were taken of the pressure attainable, too great a range of temperature began to take place in each cylinder, and the full economy due to the expansion could not be got. This led Mr. Kirk to divide the expansion into three steps, instead of as before into two. When the Aberdeen was built it was a question of boilers; for though 125 lb. would now be quite scorned as a high-pressure for a marine boiler of the ordinary type, it was then, as Mr. Kirk pointed out, a great and bold step; in taking which he was much indebted to the confidence this vessel's owners placed in him, and to the support he got from the chief surveyors of Lloyd's Registry. Mr. Kirk's communication concluded with the remark that there are few now who would dispute the importance of reducing the range of temperature in the cylinder of a steam engine as much as possible. This means successive steps, and the number of these for a given initial pressure becomes, roughly speaking, a commercial rather than a mechanical question.

Mr. J. Wright had also sent a written communication to the secretary, which was next read. He commenced by saying that he regarded what is now called triple-expansion, or three-cylinder engines, as only another step towards the final adoption of quadruple-acting engines, the consideration of which would, he ventured to think, more properly occupy the attention of the Institution at the present time. Sooner or later, Mr. Wright had stated, quadruple engines must be adopted if the economy of using very high-pressure steam was to be secured. It is not so much for the cylinders as for the slide valves and crankpins working in connection with them that quadruple action becomes so imperatively necessary. The objections of over-loaded crankpins, and also the importance of imparting power to crankshafts in more places than one, were wel

known, and if the good old rule were better observed of making crankpins one-fourth the diameter of the cylinder, or more in case of very high pressure, the principal difficulties in regard to cranks and crank-shafts would largely disappear. The proportions of cylinders Mr. Wright considered as of secondary importance. Mr. Wright then proceeded to discuss the questions of expansion and steam distribution. If the terminal pressure in the first cylinder be sufficient to secure a satisfactory terminal pressure in the last cylinder, it matters little, Mr. Wright said, what the intermediate sizes are, provided the available capacity of the slide valve ports bears the same ratio to the cylinder volume in all cases and the steam speed does not exceed 40 ft. lineal per second. It is not so much a question of four cylinders or three, as to whether four ordinary slide valves can deal with 200 lb. pressure of steam better than three. Mr. Wright disagreed with a statement contained in the paper to the effect that steam passages should be as small in capacity as possible, because, he reminded the meeting, if the exhaust steam left in the passages and clearances is at the end of each back stroke cushioned up to only the same pressure as the terminal pressure and not higher, no loss will arise from ample passages and clearances. In speaking of steam-jacketting Mr. Wright pointed out that but little additional knowledge appears to have been gained upon the subject since the introduction of Mr. Cowper's well-known hot-pot or intermediate heater. Mr. Wright said that in the course of a number of years he had taken about 170 sets of indicator diagrams from various cylinders with the ordinary steam jacket on or off, and others with the inter-heater, he had invented, either on or off. He had hoped thereby to establish some rule. The experience, however, had shown that about fourteen out of every fifteen of the cylinders were overheated by their steam jackets, indeed some so much so that they entailed a positive loss on the engine's working. Whenever the temperature of the steam in the cylinders was only slightly increased by the jacket, there appeared to be considerable economy; but when the temperature was increased largely, the economy partly or entirely disappeared. This was in consequence of the enormous friction produced on the engines by superheated steam. Although the diagram showed a large increase of power in the cylinder, the engine lost speed when working against the same load. Mr. Wright has introduced in his inter-heater an automatic arrangement for controlling, within certain limits, the temperature of the steam in the jacket, so as to vary with the main pressure in the cylinder. This had not led to good results, but without some such controlling influence, Mr. Wright considered, judging by his experience, that steam jackets on cylinders were rather a disadvantage than otherwise. In conclusion, Mr. Wright said that he considered the indicator diagrams attached to the paper, according to his manner of reading them, by no means satisfactory, as there appeared to be a considerable difference in the relative volume of steam in each cylinder, and it seemed strange, he thought, that there should be exhibited in illustration of what was called "triple expansion," diagrams showing more than 70 per cent. of wire-drawing and loss of pressure. He did not wish to say that all this loss might be recovered, but that it was excessive and principally due to defective valve arrangement.

Mr. Beaumont thought that there was a danger of the practical experience gained by actual work at sea being too much neglected. He would not undervalue indicator diagrams, but the actual coal burnt on long voyages was the criterion by which owners assessed the value of their ships.

Mr. Mudd spoke next. He referred to the diagrams shown at the last meeting, but these had been altered to those then shown on the walls. From these it would be seen that the use of piston valves did not, as some supposed, necessarily cause constricted passages. He next proceeded to discuss the question of the construction of theoretical indicator diagrams, more especially with reference to the effect of clearance and compression on the expansion curve, illustrating his remarks by the aid of the black-board. He differed from Professor Kennedy in some respects, and asked him to take the question into his consideration during his labours on the Research Committee.

Dr. Ryan was the next speaker. He said the author had laid down three conditions of efficiency consisting of three equalities; "firstly, in the range of temperature in each cylinder; secondly, in the initial stress on each crank; and thirdly, in the indicated horse-power of each engine." It appeared to the speaker that there was some danger of elevating the first condition into an article of faith, in the sense of the little girl who defined that virtue as a belief in something which was known to be impossible. There was no special merit in equality in the abstract. There appeared to be a fear that inequalities in the ranges of temperature in each cylinder aggravated on the whole the evils of condensation. The speaker thought that this could not be the case if the action of the sides of the cylinder was merely proportional to the first power of the range of temperature, and even if, as seemed to him likely, it was proportional to the second power or some other function of the range, yet he would not consider the slight possible gain important enough to determine any alteration in design or dimensions. Of the three equalities mentioned, he considered the third the most desirable, since the equality of power insured ease and regularity in turning. With regard to the compatibility of the three equalities, he would point out that theoretically the first condition followed from the third. If the triple-expansion engine were a reversible engine this would be the case; "reversible" in academic slang, and not according to the phraseology of the stokehold. The speaker then appealed to the diagrams on the wall, to prove that large inequalities in the stresses did not at all affect the connection between power and temperature range. Condensation in the cylinder depended upon three things: (1) on the range of temperature; (2) on the area of surface exposed to steam; (3) on the quantity of the metal that may be involved in the thermal changes. The third element depends on three others: (1) on the time involved in the periodic changes of temperature T; (2) on the conductivity of the metal c; and (3) on the capacity for heat of the metal s. Hence the mass of metal practically affected in each stroke would vary as

$$\frac{\sqrt{c}\,T}{s}$$

a formula which the speaker placed on the black-board. Professor Kennedy had alluded to the high-pressure cylinder as the unruly member, and had recommended that it should be jacketted. Every diagram on the wall showed that in Mr. Wyllie's practice the high-pressure cylinder was distinctly more efficient than the low when one compared the powers developed with the ranges of temperature, although Mr. Wyllie's low-pressure cylinders were jacketted and the high-pressure not. The following were some reasons why the speaker considered that the jackets would be more usefully applied to the low-pressure and intermediate cylinders. Assuming equality in the ranges of temperature: 1. Expansion occupies less time in the high-pressure. 2. The area of piston and cylinder end is a larger fraction of the whole area uncovered in the stroke in the low-pressure cylinder, and these ends are exposed to steam throughout the whole stroke. 3. The proportion of metallic surface to weight of steam increases in each successive cylinder. 4. The weight of metal involved in the thermal changes will be greater in the cylinders which expose the larger surfaces. 5. Condensation in the high-pressure lubricates the cylinder. This dispenses with oil and its consequent evils at high temperature and with surface condensation. 6. The steam gets wetter and wetter as it passes through the cylinders. 7. Condensation in the low-pressure produces more ultimate loss than in the high. 8. A steam jacket on the high-pressure would be partly idle during admission, and considering the high mean temperature in the first cylinder would be very little better than efficient lagging. 9. A steam jacket would be very effective on the second and third cylinders on account of the large gradient of temperature between boiler steam and steam in these cylinders.

Mr. Halpin, referring to the question of steam jackets, said he believed in them especially in marine practice, where cylinder liners were so largely used. As to draining the jackets, this was a simple matter in vessels of the mercantile marine where there would be a considerable drop from the cylinder to the boiler, and he would therefore put the jacket, so far as designing went, on the same basis as the bed-plate; it should be planned to perform the function required of it and there the trouble should end. He would meet the difficulties inherent in the measuring of feed water on board ship by the use of water meters. They might not be strictly accurate perhaps, but at any rate they could be got to work within 3 or 4 per cent. of absolute truth, which was far more satisfactory than some of the results obtained by calculation judging from the disparity of figures of different persons. Mr. Halpin next referred to the records of some experiments made by Professor Thurston in America, in which 500 horse-power was measured by means of a brake acting on a wheel. The question of ports was one of compromise, and if they were made too large an evil equal to excessive clearance would be engendered. In considering the results set forth in the paper the speaker pointed out that all the coal was not weighed, and an error might have crept in in this way; he also pointed out that barometer readings were not given by means of which the vacuum could be corrected. Then as to three-crank engines, no doubt these were good so far as regarded an equable turning moment, but the question had to be considered whether there was not some danger from the additional bearings getting out of line. The effect might be very different after the engine had been in work some time from that when it was fresh from the shop.

Mr. Linnington, of the Admiralty, was the next speaker. He said that he had had brought before his notice the engines of different makers, and found that in practice there was considerable difference of opinion as to the velocities for steam during admission and exhaust. [He referred to the diagrams in Mr. Wyllie's paper, especially those marked Figs. 1, 2, 3, 6, and 7 in ENGINEERING of November 5, 1886; there an alteration in the pipes made a difference of 10 lb. initial pressure, the boiler pressure remaining the same; and an increase of ten revolutions made a difference of $1\frac{3}{4}$ lb. in the back pressure of the low-pressure cylinder. The particulars of the pipes, ports, and passages in these cases would be valuable information for engineers. He advocated the adoption of a higher piston speed with a higher number of revolutions for modern marine engines. The advantages were smaller engines, shafting, and propellers, and therefore less first cost, lighter weights, and less space. No doubt there would be some increase of wear and tear, but with the three-crank engine now becoming so popular for triple-expansion, a well-balanced engine was secured. This, together with the use of steel moving parts, reduced wear and tear to a minimum. Moreover, a high piston speed was probably favourable to economy of steam with the high pressures now used. As discussion had been invited on forced draught, he might say that in warships a 50 per cent. increase on the natural draught power was carried in a few blowing fans and light air screens instead of in 50 per cent. of the boiler capacity, and with usual natural draught proportions of heating to grate surface the consumption of fuel per indicated horse-power was only slightly increased. This increase was of very little moment, as the top speed was seldom required, whereas the advantages of light weights and small space for the boilers were always present. In the mercantile marine, excepting a few special ships, there was no probability of forced draught becoming the general practice unless a diminution of the consumption of fuel could be secured, and that without deterioration of the boilers. Any reliable information on these points would be most acceptable to marine engineers.

Mr. Schönheyder criticised Mr. Mudd's remarks as to the influence of port and clearance spaces on the indicator diagrams, thinking the latter had been led astray as to the influence of compression on the expansion curve. He also referred to the facts given by Mr. Parker with reference to the influence of forced draught on boilers. The difficulties of measuring the volumes of feed and circulating waters at sea, were, the speaker said, very great. He had had brought before his notice some feed pumps which had been designed so that air would be excluded. If these could be relied on would they not give a measure of the water fed into the boiler supposing the revolutions of the engine were taken?

After a few words from Mr. Davey on the question of piston speeds, the President said he was reluctantly compelled to bring the discussion to a close, but any other members who had remarks to make would have them inserted in the Transactions —in accordance with a rule recently made—if they would forward them to Mr. Bache.

The meeting then adjourned until the next evening.

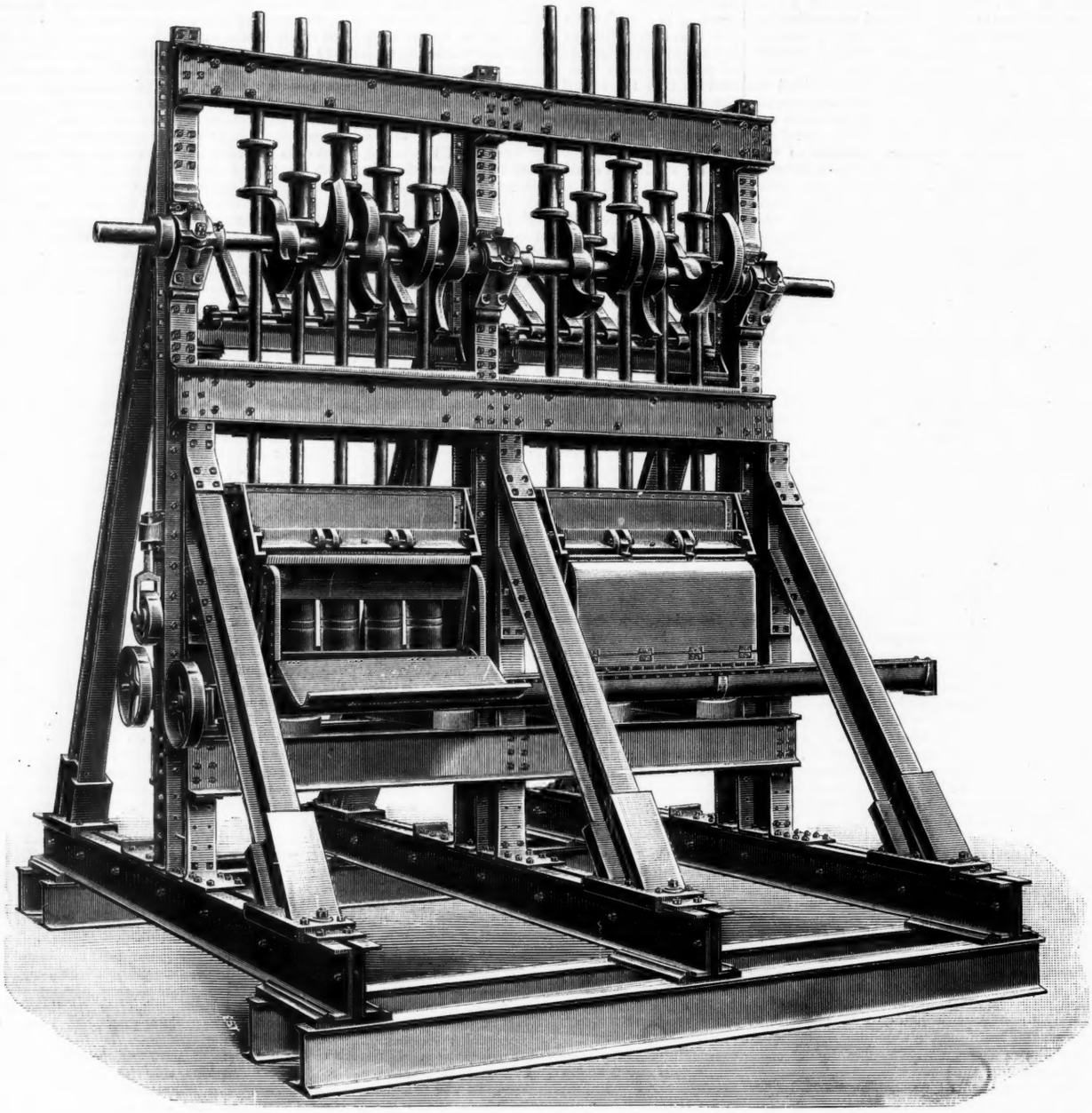
A PORTABLE HYDRAULIC DRILL.

The first paper taken on re-assembling on Friday evening was a contribution from M. Marc Berrier-Fontaine, of Toulon, in which he described a new

IRON-FRAMED STAMPER BATTERY.

CONSTRUCTED BY MESSRS. R. DAGLISH AND CO., ENGINEERS, ST. HELEN'S, LANCASHIRE.

(*For Description, see Page* 128.)



drilling machine. This paper we print in full, with illustrations, on page 130, and we may therefore at once proceed to the discussion. This was not of a very important nature, owing no doubt to the fact of the paper being taken first and the room not being at all full. Mr. Jeremiah Head was the first speaker. He wished to know whether a loss of power was entailed by the use of the flexible shaft, and, if there was such a loss, what became of the power? Did it go to heat the shaft? Mr. Schönheyder asked whether the number of revolutions mentioned referred to the machine either loaded or running light. Another speaker referred to the use of flexible shafts in America, but the one shown in the drawing was thicker than any he had seen in the United States. Another speaker, whose name did not transpire, said that hydraulic drilling machines similar to that illustrated in the paper had been used at the Forth Bridge works. He doubted if there was a material loss of power in the flexible shaft. There would be a loss due to the first winding up of the material at starting, but this would be given off again when the motive power ceased.

The President said that those who had worked in the shop knew the objection to the use of the ratchet brace, and the drill now described would be a welcome adjunct to the mechanical appliances at the command of engineers.

The next paper taken was that of Mr. Rathbone, on "Copper Mining in the Lake Superior District," which we intend to print in an early issue. We must defer our report of the discussion on this paper and also on the paper on "Pumping Engines," which followed it, until next week.

In the course of the proceedings the President announced that the annual summer meeting would be held in Edinburgh either in the first or second week in August. The Forth and Tay bridges would supply the chief objects of interest, and it was proposed to call at Newcastle on the way back, to see the Exhibition to be held there.

THE SOCIETY OF TELEGRAPH ENGINEERS.

At the meeting of this Society on Thursday evening, January 27, a paper was read by Professor Silvanus P. Thompson, who, after classifying the various telephonic systems and transmitters in use, proceeded to the proper subject of his communication, namely, "Telephonic Investigations."

His own researches in this field began, as he informs us, in 1878, when he observed that a thermopile in circuit with a low-resistance receiving telephone was sensitive to the radiations from a singing flame. He devised at that date a special transmitter, in which the vibrations of the voice were conducted into a Kœnig manumetric capsule so that the gas flame connected therewith, being thrown into vibrations corresponding to the voice, might affect a thermo-electric transmitting apparatus. It does not appear, however, that this line of research was followed up to a satisfactory termination.

IRON-FRAMED STAMPER BATTERY.

CONSTRUCTED BY MESSRS. R. DAGLISH AND CO., ENGINEERS, ST. HELENS, LANCASHIRE.

(*For Description, see Page* 128.)

Fig. 1.

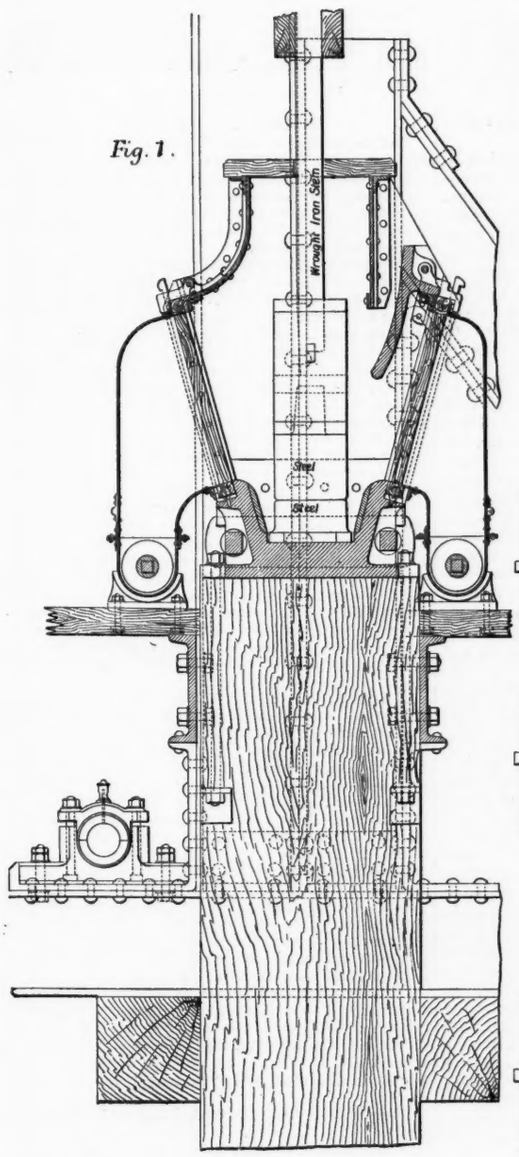


Fig. 2.

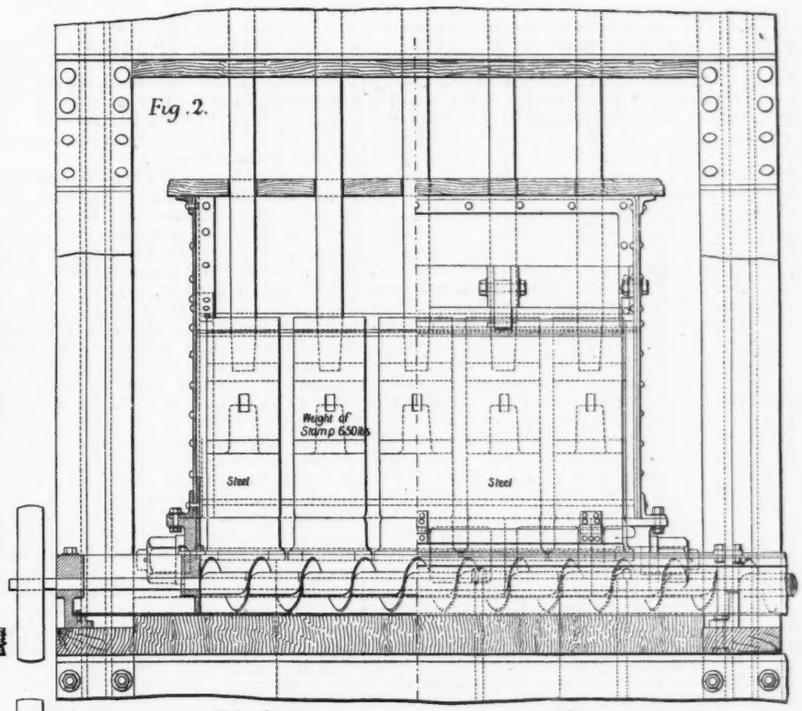
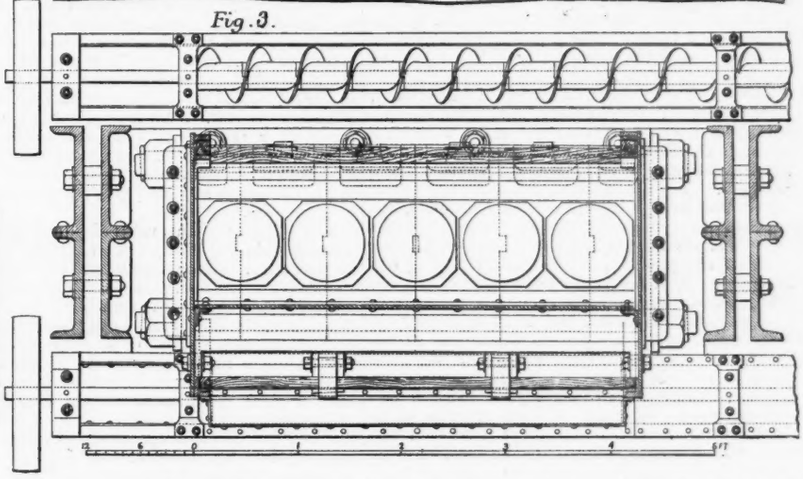


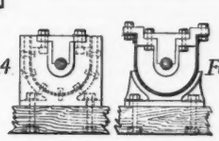
Fig. 3.



His next investigations were into the want of close correspondence between the sonorous waves and the electric impulses of the transmitter. Every diaphragm has a tone of its own; those having a low fundamental tone give the voice a "boomy" sound; those having a high fundamental tone give the voice a "tinny" sound. Moreover, all springs have a tone of their own; and further, he expressed the opinion that instruments such as the Blake transmitter, in which springs are used, do not regulate the contact in exact proportion to the vibrations. A loud sound may cause the contacts in this instrument to open so far that the circuit is broken by the parting of the electrodes, the result being a spark due to self-induction of the current, and a harsh noise in the receiver. This noise can be suppressed by suppressing the extra spark.

All transmitters in which carbon contacts are used are, according to Professor Thompson, unsatisfactory in transmitting sibilants and shrill whistling sounds. This, he believes, is due to the nature of carbon, since other substances which he has tried give the sibilants very well. Another drawback to existing telephones was the feebleness of transmitters in use, except, perhaps, the Hunnings and Gower-Bell, and this Professor Thompson sought to remedy

Fig. 4 *Fig. 5.*



by his investigations. He argued that a powerful transmitter would enable us to use less sensitive receivers and thus eliminate in a simple way the induction noises sometimes so troublesome.

Diaphragms are useful in condensing sound on the current regulator, and in guarding it from the moisture of the breath, which is apt to condense on the contacts and impede their action. Professor Thompson found, however, that a short length of speaking tube will answer this purpose. In 1884 he devised the "nest telephone," in which several contact pieces rest in a nest of cotton wool or slag wool, and the voice is conducted to them by a speaking tube.

In conjunction with Mr. Phillip Jolin he next devised the "valve" telephone, which is manufactured by the New Telephone Company, and has already been described and illustrated in our pages. In this instrument a ball conductor (the valve) rests on three contact points at the small end of the speaking tube; and loudness is obtained by connecting several of these together. The "grid" form is constructed of loose pencil conductors in the form of a grid; and it can be operated by speaking direct to it or by the mechanical vibrations of the head or throat. This property of the microphone was noticed by Mr. Preece and Professor McKendrick in 1878, or thereabout. Professor Thompson has devised a transmitter for long-distance telephony which has 108 microphones arranged in 54 parallels; the pencils being two in series. They can also be arranged all in parallel if desired. They are grouped in multiple grids, each grid containing twelve microphones. The motion is communicated to the grid pencil by a central vertical rod which is connected to the centre of a mica diaphragm 5 in. in diameter. It is said to work very satisfactorily, as we do not doubt it will.

To increase the energy of the voice actuating it Professor Thompson has been trying a device suggested by the "motograph" of Edison. A friction roller rotates slowly and is pressed upon by an extension of the rod which supports the central bars of the layers of microphones and agitates them

with a drag and slip motion. The voice is caused to affect the drag and slip motion by altering the pressure of the surfaces, and thus to affect the microphone mechanically.

In working at this apparatus the effect of heat on a microphone was noticeable. It is well known now that microphones work better when they are warm, and M. Ochorowicz has devised a transmitter in which the carbon points are specially heated.

Professor Thompson has tried various arrangements of microphones in which heat was led by copper rods from a small gas jet to the working contacts, but he has not yet arrived at a final form. Further, he found that if one contact were heated and the other kept cool, the microphonic joint became more sensitive to sound. In fact the actual transfer of heat across the loose contact of the circuit seems to facilitate its action as a telephonic transmitter. He also observed that the layer of vapour under acidulated water in the spheroidal state acts as a microphone transmitter or receiver; the water and hot metal plate beneath being the electrodes. The high resistance of the vapour and the instability of the water is, however, a disadvantage.

Professor Thompson then adverted to the theories of microphonic action commonly accepted. These are, as stated by him, the theory that the action is due to variation of the resistance of the material under pressure, a theory put forth by Edison. The second theory mentioned by Professor Thompson is that the effect is due to variation in the number of points of contact. Professor Thompson did not see fit to notice a third theory which is probably as correct as any of these, namely, that which attributes part of the effect, at least, to the intervening couch of imperfectly conducting material between the vibrating points. Perhaps he has satisfied himself that this theory is erroneous. However that may be, we have his opinion that whilst the first of the theories enumerated by him is known to be wrong, the second is apparently imperfect. He points out that the most highly polished surfaces are quite rough to the scientific imagination, and that when these are treated as microphonic points are, by passage of the current, the particles forming them must be agitated irregularly. "What a jostling of molecules, what innumerable batterings, what millions of minute electric discharges; air particles, nay, even solid dust particles torn from the two surfaces flying to and fro between them, forming a veritable Crookes layer. Then think what is the meaning of putting more pressure on to such a 'contact.' The thousands of molecular makes and breaks that were going on will be multiplied, the paths of the flying molecules shortened, more current will flow, heat agitations become still greater. Take off the pressure, the two surfaces fling one another apart, or bombard one another apart; discharge takes place more slowly; the apparent conductivity of the layer is reduced. Move the surfaces still further apart, the atomic clash and atomic bombardment is still further enfeebled. Separate them by a visible distance—like the spheroidal drop separated visibly from the hot plate beneath it—still there are molecules at work between them. Will any one undertake to say that at sensible distances, such as one-thousandth of an inch, or even one-hundredth of an inch apart, no discharge takes place at all across the gap?" Much of the foregoing seems to be an argument for the theory which Professor Thompson omits to mention—the theory, in fact, which does not limit the action of the microphone to mere variation of the number of points in contact, but which also includes the conductive action of the air between, acting on a variable gap.

There should be perfect clearness of ideas on this point. The theory which Professor Thompson deems imperfect is to the effect that the number of points of contact between the conducting points of the microphone varies in proportion to the vibrations, and alone causes the variation of current. He himself brings in the operation of the air gap varying in width and effect with the vibrations. But this element is by no means new, and is in fact a portion of the third theory which for some reason he ignored.

Having put this matter in, we trust, a clearer light, we are at liberty to cite the conclusion of Professor Thompson. He says, "The more one thinks of the matter from the point of view of the molecular vibrations, the more plain is it that every transmitter that works by varying the resistance of the circuit . . . . (those of the loose contact type) works by varying the number of molecular contacts, and that the most perfect transmitter will be the one which does this in the most effective correspondence with the displacements in the air caused by the speaker's voice, and will give the effect of undulation when the air particles merely undulate, and will give the effect of intermission when there is intermission between the motions." Professor Thompson also remarked that these considerations may help to explain the action of heat in assisting microphonic action, and that what heat can do can also be done by auxiliary vibrations of such periods as shall not interfere with the tones of the voice. He has lately had an apparatus constructed to test this point.

After touching on the surface deterioration of metals the author enumerated a number of materials he had tried to replace them in the microphone. These are native arsenic, mispickel, ilmenite, allemontite, black crystals of specular iron ore, magnetite, micaceous iron, cloanthite, pentlandite, clausthalite, redruthite, chalo-pyrites, smaltine, and pyrosulite. Of these micaceous iron was the best, but difficult to obtain in workable pieces. Copper treated with tellurium or selenium, or mixtures of selenium and sulphur, gave surprising results. A hard and brittle bronze thus formed takes a high polish like steel, and yields when in contact with platinum a microphone giving very crisp speech, superior to carbon. This alloy was used for the valve-piece of the valve telephone, but its surface was found to acquire a film, probably of selenic acid, which gave rise in time to curious whistling sounds. Nickel, osmium, and palladium answer well. As has been repeatedly observed and pointed out by various workers in this field, metal contacts do not permit so large an amplitude of vibration without break of circuit as carbon; but Professor Thompson mentions that there is at least one exception in the case of copper selenium. It required a greater initial pressure at the points than hard carbon. So also does chalco-pyrites, a substance suggested by Mr. P. Rabbidge.

Professor Thompson afterwards dealt with the subject of induction coils, or transformers, used in telephony, and described the differential transformer of Jolin and himself, which is used with the valve telephone and has been described already in our pages. It suppresses the rattling sounds of a breaking circuit. What is required in a telephone transformer is maximum mutual induction and minimum self-induction. Two small induction coils having their primaries connected in parallel and their secondaries in series, give a better effect than one large coil.

The speaker then referred to receivers in general, including the dynamo telephone on which he is at work, and for some forms of which a patent has been granted him, and which we described in a recent Note. All such principles as apply in dynamos to the avoidance of eddy currents, and the effective transformation of electric energy into motion, apply in the dynamo or electromotor receiver. In the dynamo telephone there is a field magnet which provides an intense magnetic field, and an armature coil which, instead of rotating in the field like the dynamo armature, vibrates under the action of the voice or conversely under the impulses of the undulatory current from the line.

Professor Thompson concluded a very able and interesting address by expressing his conviction that the path of progress lies very near the road already travelled by those who have perfected the existing machinery for the electric transmission of power.

GOLD STAMPER BATTERY.

The stamper battery which we illustrate on pages 126 and 127, is the manufacture of Messrs. Robert Daglish and Co., of St. Helens, Lancashire. It is designed for easy transit over mountainous roads, and is framed with wrought iron divided into portions, of which the maximum weight is 300 lb. There are ten stamps set in two mortars, and dropping on to a corresponding number of steel dies, supported by a heavy cast iron bedplate, which in its turn is mounted on a massive wood foundation. The stamps are raised by two armed cams, which will work them at a rate as high as 110 drops per minute. The tappets or lifters are formed of cast iron, and weigh 60 lb. to 70 lb. each; they are alike at both ends, and when one face is worn the lifter can be reversed, and the other end be brought into use. The stamp head or socket is cylindrical, and is strengthened by wrought-iron bands shrunk on. The stems run through guides of greenheart timber constructed in halves, so that they may be adjusted for wear.

The crushed ore, in the dry process, passes through screens of woven wire, varying in fineness from 900 to 10,000 meshes per square inch; in wet working, the screens are plates perforated by punches varying in size from No. 0 to No. 10 common sewing needle. The crushed ore falls into worm conveyors by which it is delivered to whatever type of amalgamating apparatus which may be employed. The conveyors are driven by a belt which is kept taut by a tightening pulley.

The perspective view shows the stamper framed in the makers' shops in this country, while the detail views illustrate the additional timber work to be fitted to it at the mine.

STEAM EXCAVATOR.

The engravings on page 123 show an excavator of a design by Mr. John K. Howe, secretary and treasurer of the Osgood Dredge Company, of Albany, N.Y. It has been tested by a season of extremely hard work, digging clay in the brick-yard of Mr. Hamilton, at Croton, and, we are told, proved itself remarkably efficient and successful.

Its points of advantage are claimed to be: 1. A more efficient application of power, enabling the work to be done with a smaller engine. 2. Simpler construction, giving fewer wearing parts. 3. Greater adaptability, as it digs and dumps at any point in a complete circle. 4. Ease and economy of handling, as all the movements are made by one man only. 5. Cheapness, as owing to its lightness and simplicity of construction it can be built for half to two-thirds of the cost of an ordinary steam shovel of equal capacity.

By using the dipper handle as a lever (of course increasing its strength to stand the breaking strain) the heavy and expensive crane is avoided, and the power is applied almost exactly in the direction in which it does the most effective work, *i.e.*, parallel to the cutting face of the dipper. By fastening the hoisting drum to the upper end of the handle, instead of pulling the dipper away from the bank, and requiring special crowding apparatus to overcome this pull, the hoisting chain both digs and crowds the dipper into the bank at the same time and by the same motion; while in hard digging the power may be multiplied two or three times by varying the leverage of the dipper handle. The mechanical merit of this feature of the design is clear.

The dipper is kept from sliding out too far or crowding too fast into the bank by the backing chain, which regulates the distance at which it works. The dipper handle is made of T and angle iron, braced, of triangular section, as shown. It is free to slide lengthwise in its saddle, except as controlled by the backing chain. The height of the saddle may be changed by adjusting the stay rod. All the machinery, including the engine and boiler, is mounted on a frame of channel iron (containing a water tank), which revolves on a ring of coned rollers inside of the cast-iron turntable. On the crankshaft of the engine are two pinions with friction bands which drive the upright swinging shaft. This has a chain pinion on its lower end, from which an endless chain passes over two sheaves around the base of the turntable, so that by securing one pinion by its friction band the whole upper part of the machine revolves in either direction and as far as may be desired, and by releasing both pinions it remains stationary.

The car is built of wrought-iron I-beams, and is steadied while at work by four steel jack-screws. The machine is moved up to its work by swinging the dipper to the rear and "kicking" the excavator forward.

The machine here illustrated has a ¾ yard steel dipper, a 6½ in. by 8 in. double cylinder engine with two independent friction drums, and weighs 10 tons. It digs 15 ft. from centre of track and dumps 10 ft. above the track. Its speed in clay is two dippers per minute; in gravel, three dippers. It is handled by a crew of two men only, engineer and fireman.

LAUNCHES AND TRIAL TRIPS.

On the 26th ult. there was launched from the yard of the Sunderland Shipbuilding Company, Limited, the Plymouth, a finely modelled screw steamer built to the order of the Jersey, Guernsey, and St. Brieuc Steamship Company, managed by Messrs. Dory and Bryant. The principal dimensions of the vessel are: Length, 155 ft.; breadth, 22 ft.; depth of hold, 11 ft. The steamer is specially designed for the Channel passenger trade, and is to run between Plymouth, Jersey, Guernsey, and St. Brieuc. The engines have been supplied by Mr. John Dickenson, of Sunderland; they have cylinders 20 in. and 40 in. by 24 in. stroke, and work at a pressure of 100 lb. per square inch.

On Saturday, 29th ult., the new steel screw steamer Queen Victoria, built and engined by Messrs. Alexander Stephen and Sons, Linthouse, for Messrs. Thomas Dunlop and Sons, had her official trial trip on the Clyde. A vessel of 2312 tons gross register, she measures 290 ft. by 39 ft. by 25 ft. 4½ in., and is fitted with all the most modern improvements for safe navigation and for expeditious loading and discharging of cargo. The engines are of the triple-expansion type, the cylinders being, respectively, 20 in., 33 in.. and 51 in. in diameter. They are supplied

with steam from a double-ended boiler, 12 ft. in diameter and 17 ft. 2 in. long, fitted with four of Fox's corrugated furnaces. On trial the vessel carried about 3500 tons of deadweight. Steam was easily maintained, and the engines worked with smoothness at the rate of 59 revolutions per minute, developing 1130 indicated horse-power, and giving over the measured mile an average speed of 10½ knots, which was considered highly satisfactory.

On Tuesday, the 8th inst., Messrs. Edward Withy and Co., West Hartlepool, launched the steel screw steamer Vulcan, built to the order of Mr. Thomas Robinson, of West Hartlepool. This vessel is constructed on what is popularly known as Withy's long extended bridge type. The dimensions are 292 ft. by 37 ft. by 20 ft. 6 in., and she will carry a large deadweight cargo. The steamer will be fitted with triple-expansion engines by Messrs. S. Richardson and Sons, Hartlepool.

A handsome little screw steamer, called the Gloria, has been launched from the shipbuilding and engineering works of Messrs. J. F. Waddington and Co., at Seacombe, to the order of Messrs. Bickersteth, Baker, and Co., of Liverpool. This vessel has been specially constructed for touring and general trade on the river Amazon. She was launched with engine and boiler on board, to the satisfaction of the superintending engineer, Mr. Irwin, of Liverpool.

The Nulli Secunda, the engines of which are described on page 545 of our last volume, has just been launched by her builders, Messrs. Doxford and Co., of Paillon, Sunderland. The vessel is of 5600 tons register, and can carry 6500 tons at 11½ to 12 knots an hour with a fuel consumption of 52 tons a day. The discharging machinery is driven by hydraulic power, and was constructed by Messrs. Brown, Brothers, and Co., of Edinburgh.

MISCELLANEA.

A TELEGRAPH cable between Tangier and Gibraltar is now being laid.

At a general meeting of the Engineering Society, King's College, London, held Tuesday, February 1, Mr. A. H. Preece read a paper on "Secondary Batteries."

The inner wall on the north side of the floating dock at Limerick subsided last Saturday, the débris falling into the basin. Some 600 ft. gave way, the shipping moored within having a narrow escape from damage.

A United States Naval Committee is preparing a Bill providing that a sum of 2,450,000 dols. shall be voted towards an increase of the Navy by two new men-of-war, four gunboats, and one torpedo-boat.

Speaking at the annual dinner of the Association of Public Sanitary Inspectors, Mr. Edwin Chadwick said he believed that sanitary engineers might undertake further to reduce the death rate in London by 5 in 1000.

The telephone rate between Paris and Brussels is fixed at 3f. for five minutes' conversation; and, subject to a deposit of 60f. and to the adaptation of the apparatus at his own expense, any Parisian already having a telephone can communicate direct with Brussels.

The Committee upon Naval Contracts met last week at the Admiralty to consider their report, which will shortly be presented to Parliament. A final meeting of the Committee will be held on Tuesday next, when the report will be passed.

Mr. Wilson Hartnell, of Benson's-buildings, Leeds, has just completed an electric light installation at the flour mills of Messrs. Croysdale and Sons, Knottingly. The plant consists of one self-regulating dynamo, and sixty-three 16 candle-power Edison Swan lamps.

The directors of the Manchester, Bury, and Oldham Tramways Company report that last year there were carried 2,733,286 passengers, against 1,875,029 in 1885, and the receipts amounted to 18,774*l.*, compared with 13,695*l.* in 1885.

Regarding the projected service of fast mail steamers from China and Japan, in correspondence with the Canadian Pacific Railway, Sir Charles Tupper has said he had every assurance that the Imperial Government would immediately grant a subsidy of 100,000*l.* per annum for the service.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended January 30, amounted, on 15,386¾ miles, to 1,087,472*l.*, and for the corresponding period of 1886, on 15,257 miles, to 1,058,301*l.*, an increase of 129¾ miles, or 0.8 per cent., and an increase of 29,171*l.*, or 2.7 per cent.

The Cordelia has returned to Portsmouth at the conclusion of a week's continuous trial in the Channel. The machinery acted satisfactorily during the cruise, though less power was developed on the six hours' run than was anticipated. The Cordelia is to have two of her 5 in. breechloaders replaced by two guns of the same calibre, but with strengthened chases, before leaving.

Plans and drawings have been received at Chatham Dockyard for the first of a new class of ocean cruisers ordered to be built at that yard. The new vessel, which, it is stated, will be named the Jubilee, will be a protected vessel somewhat similar to the Mersey class, but will be smaller and fitted with machinery giving her a speed of over 20 knots per hour. She will be 225 ft. long and will have a displacemant of 2800 tons.

The works for the free ferry at Woolwich, the first to be established by the Metropolitan Board of Works, were begun last week. Two steamers are ordered for the service of the ferry from Armstrong and Co., of Elswick, and will be large enough for the conveyance at one time of several vehicles and horses and some hundreds of passengers. It is expected that a few months will see the work completed and the ferry in operation, with passages every five or ten minutes.

The United States Senate has passed two Bills providing the means for the making of steel ordnance for the army, navy, &c., this action indicating an intention to strengthen the country's defences. These Bills—by which a sum of 16,000,000 dols. is granted for ordnance, and one of 5,000,000 dols. for coast defences—were passed without opposition. Gun factories will be established at Watervliet Arsenal, New York, and also at the Navy Yard, Washington.

An express train running on the Vermont Central Railroad, from Springfield to Montreal, on Friday night, was thrown from the track by a broken rail near Woodstock, Vermont, while crossing the White River Bridge. The locomotive, two passenger coaches, and two sleeping coaches plunged from the bridge into the river, and the wreck caught fire, the coaches, with the bridge, being destroyed within half an hour. The disaster caused the loss of fifty lives.

A large ironclad, named the Pelayo, constructed for the Spanish Government by a French company, was launched at Toulon last week, having been commenced in April, 1885. The vessel is 105 metres long by 20 wide, and of 9900 tons. The two engines are of 6800 horse-power, which can be increased to 8000, and the two screws, each weighing 7500 kilogrammes, give a maximum speed of 16 knots an hour. The cost is 14,500,000f., exclusive of that of the hydraulic apparatus and artillery, and the ship will be completely equipped in another year.

Mr. Henniker Heaton, M.P., has given notice that he intends on the earliest day to call the attention of the House of Commons to the postal contracts of the British Empire, the extraordinary anomalies of the postal service; the "grave scandals" resulting from the cheaper rates charged upon letters and packets posted on the Continent for British colonies and England itself, as compared with the rates charged in the United Kingdom. Mr. Heaton will move for a Select Committee to inquire into the obstacles which prevent or impede these reforms.

Sir W. Plowden, having asked the First Lord of the Admiralty whether the arrangements for improving the administration of the dockyards and reducing the expenditure and time occupied in building and repairing ships, arrangements which were commenced last year by the appointment of a director of dockyards and civil assistants to the naval superintendent, had yet been completed; if not, to what extent had offices yet to be filled in the department of director of dockyards, and what was the cause of the delay. Lord G. Hamilton said in reply that the arrangements are completed, but the composition of the staff of the director of dockyards has not yet been finally decided upon by the Admiralty.

The two days' sale of the electric plant, machinery, engines, and boilers, used at the late Exhibition held at South Kensington, drew together a large company. The electric light cable, of which there were between thirty and forty miles, and some of which had been used since the commencement of the series of exhibitions, was offered in sixty lots, and realised from 50*l.* to 100*l.* per ton. The machinery included ten engines of an aggregate of 1700 horse-power and eleven boilers. The engines were sold for a total sum of 2900*l.*, and the boilers for 183*l.* each. The proceeds of the electric plant, machinery, engines, and boilers amounted to about 10,000*l.*, the aggregate proceeds of the two sales being 17,000*l.*

Mr. Raikes has stated in Parliament that he had concluded arrangements with the Cunard and the Oceanic Companies for the conveyance of mails from Queenstown to New York. The price to be paid for letters is 3s. per pound, as compared with 4s. paid under the old contract, and 3s. 6d., the lowest sum for which the Cunard and Oceanic companies tendered on the last occasion. In addition the Post Office will send mails by other fast steamers either from Queenstown or from Southampton. This plan will practically give four mails a week from this country to America, viz., every Tuesday, Wednesday, Thursday, and Saturday, besides the occasional chance of sending by such fast steamers as the Alaska, the Arizona, and the City of Rome.

We take the following from a daily contemporary: "We hear this morning, from one who was in the competition, that Sir Evelyn Wood's Committee has practically decided upon the new army rifle. Nearly one hundred different rifles were submitted, but the Lee, an American magazine rifle, was finally chosen, subject to the subsequent tests. Three hundred have been ordered for the purposes of testing at the butts. All the rifles of the German type were set aside, because of the inconvenience arising from the magazine being placed along the stock underneath the barrel. The magazine in the case of the Lee is immediately under the firing chamber, acting somewhat on the principle of the revolver. It can be fed singly, or two or three cartridges can be inserted at a time, and does not require to be completely emptied, as in the case of the Mauser, before being refilled. An improved Enfield rifle was in final competition with the Lee, but the choice was made as we have stated."

The Italian Government have, it is understood, just completed arrangements which will seriously affect the large firms of English marine engineers. Hitherto the engines for their colossal battle ships have been manufactured in this country, but the Italian Government have now determined to construct the machinery required for the naval service in Italy, and arrangements have been made with a native firm at Genoa for supplying propelling engines of the enormous force of 12,000, 20,000, and 25,000 horse-power respectively for vessels now in course of construction at Spezia and Castellamare. The manufacture of the engines will be under the supervision of three English engineers who have been expressly engaged for the purpose. One will undertake the duties of instructor of fitters, another that of inspector of boilermakers, while the third is to perform the functions of chief inspector, and will have to certify that the engines are fit for the naval service before they are taken over by the Government from the contractors.

Last week a deputation from the National Society for the Prevention of River Pollution waited upon the President of the Local Government Board to obtain his approval of a Rivers Purification Bill proposed to be introduced into Parliament. The deputation was introduced by Lord Abinger, and there were also present the Earl of Hardwicke, Sir V. Kennett-Barrington, Mr. Hastings, M.P., the Hon. W. F. B. Massey-Mainwaring, and a number of medical officers of health. Mr. Ritchie said there were one or two provisions in the Bill which he was quite sure the Government would not support, and which, even with that support, would never pass the House. One in particular was the clause allowing a private person to put the law in motion in the name of the local sanitary authority, and at its expense. Further, there did not seem sufficient regard paid to manufacturing interests. He might say that the Government intended to give to the County Boards, which they hoped to establish, the power of dealing with the question of river pollution, and it was hoped that this would meet the requirements of the case.

The first 110-ton gun, the heaviest weapon ever made in England, was safely conveyed to the proof butts at Woolwich Arsenal last week, for the purpose of undergoing its preliminary trials. The gun had previously been placed on the carriage from which it will be fired, and this being fixed on a broad-gauge trolly, was easily taken over the Arsenal railway by four large locomotive engines. The carriage weighs nearly 100 tons, independently of the gun, and some apprehension had been felt for the bridge crossing the canal, but this had been strengthened by the Royal Engineers, and tested by the passage over it of a dead weight of pig-lead, &c., weighing in all 230 tons. On arriving at the butts the gun was placed upon the inclined rails known as the Maitland platform, and it is now ready for proof. The bore of the gun is 16½ in., and it will fire a projectile of 1800 lb. weight, but the charge of powder cannot be determined until after full trial. The proof will begin with a small quantity and be gradually increased as the powers of the gun are demonstrated. A new powder, specially manufactured for very large guns at the Government works, Waltham Abbey, will be employed in the experiments. The gun was supplied under contract by the Elswick firm.

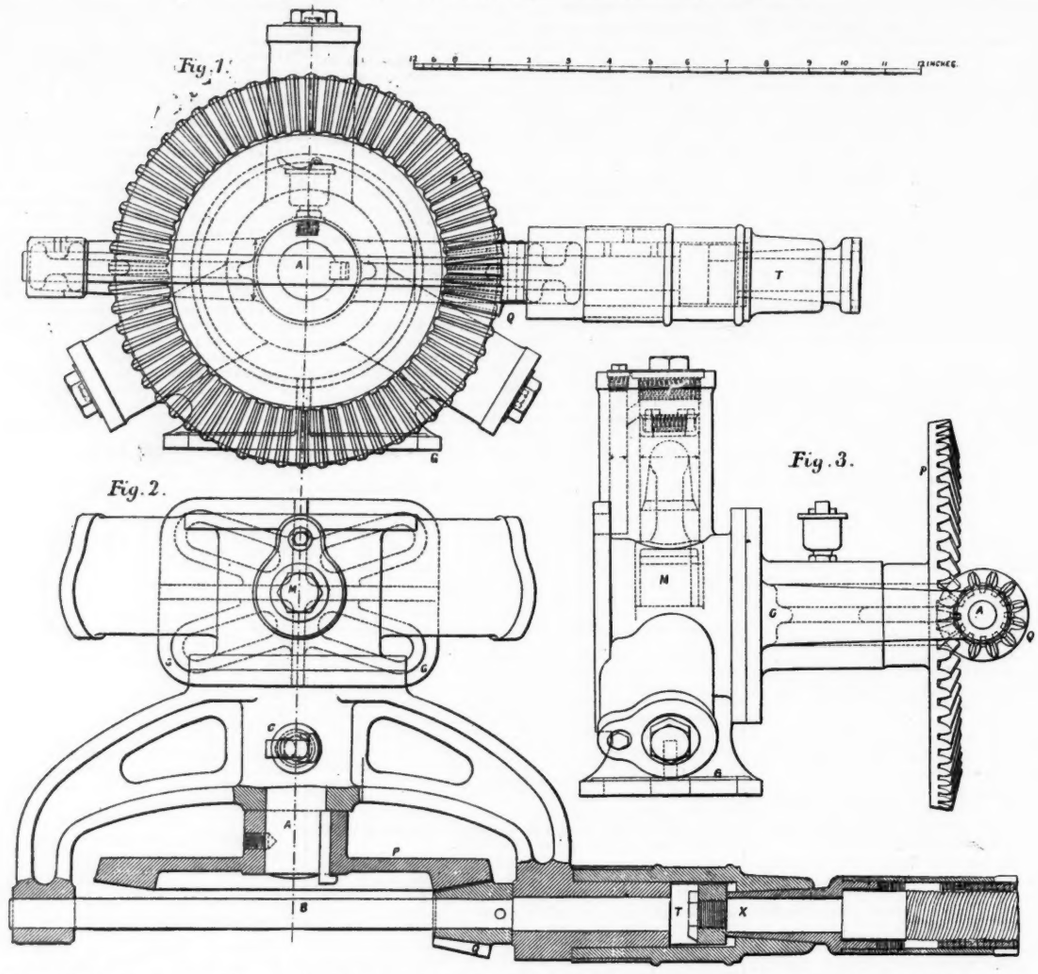
DENSITY OF LIQUID AIR.—M. Wroblewski has made a series of experiments to determine the density of liquid atmospheric air. The value found by experiment is 0.59 at—146.6 deg. Cent., and 45 atmospheres of pressure. Calculations from the densities of liquid oxygen and nitrogen give the figure 0.6.

SPONGE IN WATER PIPES.—The Transactions of the American Society of Civil Engineers give particulars of some researches made by Mr. Desmond Fitzgerald on the growth of *spongilla lacustris* in water pipes. Pieces find their way from the source of supply into the system. These decay and give a cucumber-fishy taste to the water. The sponge is really an animal which lays eggs. Large mains under a pressure of 100 ft. have been filled with offensive masses which cannot be removed by flushing, scrapers or wire brushes being necessary.

THE INSTITUTION OF CIVIL ENGINEERS.—At the ordinary meeting on Tuesday, February 1, Mr. Edward Woods (President) in the chair, it was announced that Edward Buckham, William Allan Carter, John George Hudson, John List, Percival Walter St. George, and Arthur Moore Thompson, associate members, had been transferred to the class of members. At the same meeting it was reported that the following twenty-one candidates had been admitted as students, viz.: Arthur Stowey Bailey, Alfred Jackson Batt, Francis George Coles, Herbert Evington, Clarence Noël Goodall, John Joseph Hedges, Henry Wilson Hodge, Follett Holt, William George Crawford Hughes, William Marshall Huskisson, Herbert Sidney Jurd, Norman Larchin, Percy Edward Lewis, Edward Bickerton Milward, Arthur William Pritchard, Lazarus Simon Magnus Pyke, F.C.S., Harry Richardson, Richard Stanfield, Wh. Sc., William Elphinstone Underwood, William Henry Wickham, and George James Wooldridge. The monthly ballot resulted in the election of three members, viz.: Alexander Joseph Bolton, William Buchan Christie, and Charles Edward Livesay; and of twenty-five associate members, viz.: Robert Ogilvie Newton Anderson, B.A., B.E., Stud. Inst. C.E., Jonathan Angus, James Rae Baterden, Frederick Bluett, Stud. Inst. C.E., Robert Henry Burnside Downes, Stud. Inst. C.E., Henry Somerville Fearon, Stud. Inst. C.E., Maurice Fitzmaurice, B.A., B.E., Stud. Inst. C.E., Arthur Edmund Breton Hill, B.A.Sc., Robert West Holmes, John Bagot Labatt, Stud. Inst. C.E., Alexander Gordon McBeath, Frederick York Marrian, Stud. Inst. C.E., Donald Alexander Matheson, Thomas William Potter, Stud. Inst. C.E., Samuel Rebsch, James Robert Robertson, James Robinson, John Burn Antis du Sautoy, Edward John Silcock, Stud. Inst. C.E., Cyril Smith, Henry Badeley Smith, Charles Alexander Stevenson, B.Sc., F.R.S.E., James Pickles Wilkinson, William Winstanley, and Fred Spencer Yates, Stud. Inst. C.E.

PORTABLE HYDRAULIC DRILLING MACHINE AT TOULON DOCKYARD.

DESIGNED BY M. MARC BERRIER-FONTAINE, TOULON.



PORTABLE HYDRAULIC DRILLING MACHINES.

*Description of a Portable Hydraulic Drilling Machine.**

By M. MARC BERRIER-FONTAINE, of Toulon.

THE small portable hydraulic drilling machines, shown by Figs. 1 to 7, on the present and opposite pages, are capable of drilling in their place and after erection nearly all the holes required for rivets, bolts, &c., in all kinds of iron or steel structures—such as ships, bridges, girders, and boilers—wherever hydraulic pressure is available for working them. With these portable machines the parts can be drilled in their places as rapidly as they would be drilled by stationary drilling machines in the shops, the shifting of the portable machine from one hole to another being as easily accomplished as the shifting of a piece of work of equal weight under a stationary machine. In this way holes are drilled in place even more readily than the same holes could be severally drilled by a stationary machine in the shops; because by drilling in place a single operation serves to drill through all the superposed thicknesses without stopping the drill; whereas when the pieces are separate, as in the shop, as many separate drilling operations are required as there are pieces, and the work consequently involves much more labour and time. Besides effecting considerable saving this mode of drilling in place presents also the great advantage of insuring that the holes are quite true through all the superposed thicknesses, without having been previously set out on each separate piece, and thus all such preparatory work is dispensed with, as well as the labour and time necessary for carrying the separate pieces, first to the drilling shop from the places where they have been marked, and then back again to their places after they have been drilled.

The size and weight of the portable hydraulic drills, by which these advantages are secured, are so small that these machines can be used for drilling nearly all the holes required in the most complicated structures, even in the most confined spaces; and they can be used for driving the drills either directly or through flexible shafts or other intermediate apparatus. In the accompanying diagrams is shown one of the two sizes of portable hydraulic drilling machines which have hitherto been made by the author for use in Toulon Dockyard. Other sizes for different powers could be easily designed as they might be required.

The drill shown in Figs. 4 to 7 is of 1 horse-power, and drills holes up to 2 in. in diameter, either directly, as in Figs. 4 and 5, or through a flexible shaft, as in Figs. 1 to 3, the driving shaft making 90 revolutions per minute; the sockets of the drill-holder, and of the flexible shaft No. 8, which can be fixed to it, are identical with those of a No. 4 Morse twist drill, and consequently fit the conical shanks of the twist drills from $1\frac{5}{8}$ in. to 2 in. in diameter. The smaller machine is of $\frac{1}{2}$ horse-power, and drills holes up to $1\frac{1}{4}$ in. in diameter, either directly or through a flexible shaft, the driving shaft making 150 revolutions per minute; the sockets of the drill-holder, and of the flexible shaft No. 6 which can be used with it, are identical with those of a No. 3 Morse twist drill, and therefore fit the conical shanks of the twist drills from $\frac{13}{16}$ in. to $1\frac{1}{4}$ in. in diameter.

Each drilling machine is composed of two parts:

Firstly, a small hydraulic motor M, driven by water pressure supplied from a main through flexible or jointed pipes, like those commonly used for portable hydraulic rivetters. The discharge water is led away through india-rubber tubing. The motors shown in the drawings are Brotherhood's three-cylinder engines, but other hydraulic motors could be applied, provided they are sufficiently light and compact.

Secondly, a drill-holder, consisting of a small frame of C shape, in which are arranged the bearings of the driving shaft A from the motor, and of the hollow drill spindle D at right angles to it. On the motor shaft A is keyed a bevel wheel P (Fig. 4) gearing with a bevel pinion Q on the drill spindle D. At one end of the drill spindle is a socket for holding the drill; and the other end is threaded internally for receiving the setting-up screw S, which is turned by the hand-wheel V either to give the feed whilst drilling or to withdraw the drill when the hole is finished. A longitudinal slot R for the key of the bevil pinion Q allows the drill spindle to slide through the pinion while the latter is kept in place by an annular recess E. Beyond the handwheel V the screw terminates in a point, which can be pressed against a crosspiece or frame, such as is used for drilling with a ratchet-brace. The central part of the frame C is bolted to the flange of the motor M, and thus forms a long bearing for the shaft A; and small closed lubricators insure the bearing being properly oiled, in whatever position the drill may be held. In the base G of the motor are slotted holes, for fixing it by bolts put into holes in the structure, thus insuring perfect steadiness in drilling. A ring with two handles (Fig. 6) is placed at the centre of gravity, so that a workman can easily carry the drill from place to place.

When the drill is driven direct, the drill spindle D is geared to run at the same speed as the driving shaft A of the motor, by making the two bevel wheels P and Q of equal diameter, as shown in Fig. 4. But when a flexible shaft is used for conveying the power from the motor to the drill, the flexible shaft itself must be made to run five times as fast as the motor shaft and the drill; it is therefore geared both to the driving shaft A at one end and again to the drill spindle at the other end by bevel wheels in the proportion of five to one, as shown in Figs. 1 and 2. The flexible shaft is fixed at one end to the pinion Q by a clutch similar to that used for attaching it to a driving pulley; and the other end similarly drives the drill. In this case the drill spindle B has no longitudinal movement, the feed of the drill being given at the other end of the flexible shaft, by means of the screw belonging to it.

Owing to the great importance of reducing to a minimum the weight of these portable machines, so that they may be shifted as easily as possible from hole to hole, they are made entirely of steel and phosphor-bronze. By this means the weight of the whole machine complete, including the two stop-valves for inlet and outlet, does not exceed 105 lb. for the 1 horse-power drill, and 62 lb. for the $\frac{1}{2}$ horse-power. Trials made for a lengthened period have proved that, on board a large armour-clad man-of-war, built on the cellular system and consequently of very complicated design, the number of holes drilled in place by these small hydraulic machines is at least 25 per cent. greater than the number of similar holes that can be drilled in the same time by stationary machines in the shops; and is at least six or seven times greater than the number of similar holes that can be drilled in place by ratchet-braces.

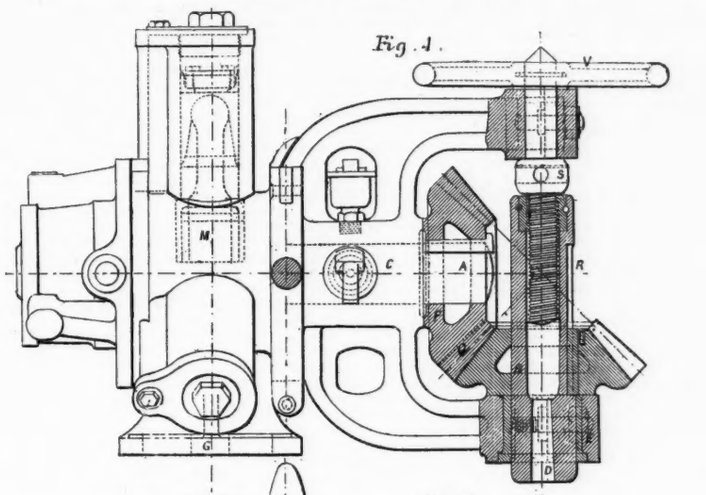
The first two of these drills, which have now been in regular use for nearly two years in the Mourillon yard at Toulon, have been found so advantageous in working, alike in quality and rapidity and economy of work, that fifteen more have already been ordered for the same yard, of which five will be of 1 horse-power and ten of $\frac{1}{2}$ horse-power.

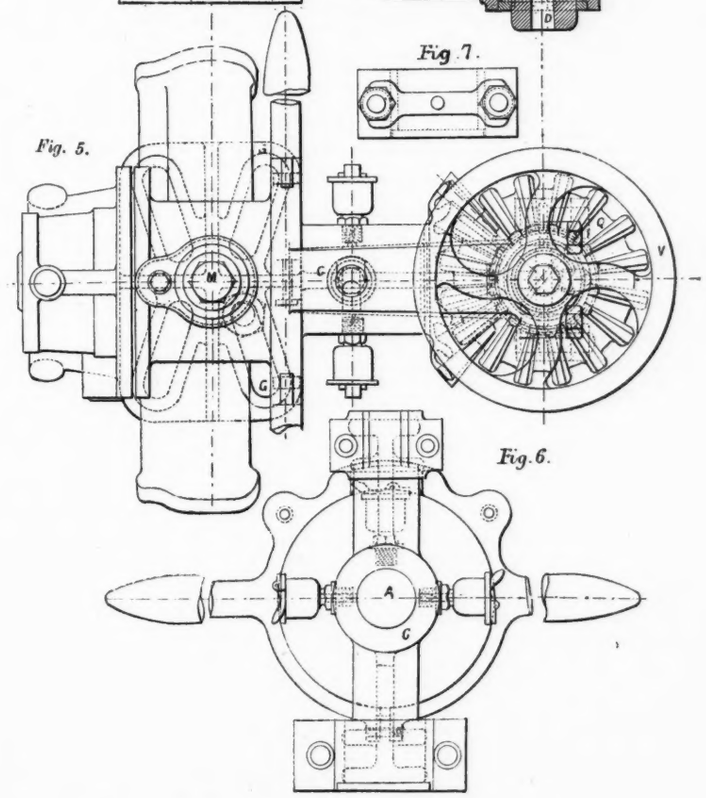
* Paper read before the Institution of Mechanical Engineers.

PORTABLE HYDRAULIC DRILLING MACHINE.

DESIGNED BY M. MARC BERRIER-FONTAINE, TOULON.

(*For Description, see opposite Page.*)





NOTES FROM THE UNITED STATES.

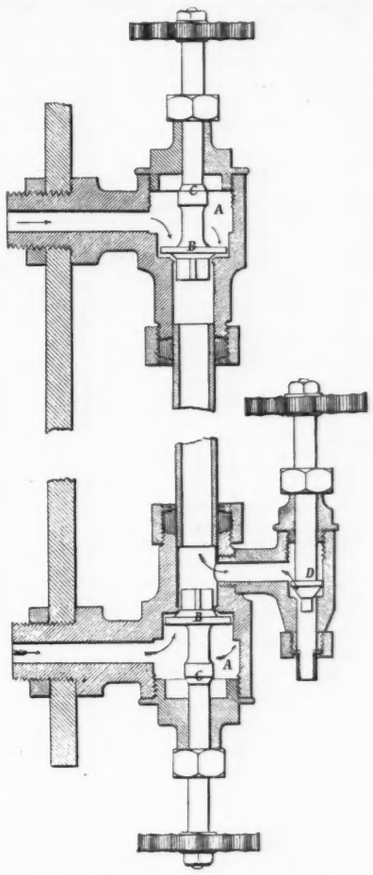
PHILADELPHIA, January 28.

THE entire American market continues in a feverish condition; prices are firm in all markets between New York and St. Louis. No further advance is probable for the present. Buyers have withdrawn their offers, in many cases because finished material has not advanced in the same ratio as crude. Nails, bars, and plates have advanced slightly within a week, and a further advance will be announced in about ten days. Pig iron is selling at 21 dols. to 22 dols. for No. 1, foundry for 22.50 dols. asked, No. 2 is selling from 20 dols. to 25.50 dols. Grey forge from 18.50 dols. to 19.50 dols. Crude iron is selling only in small quantities. Offers for large lots were refused by the furnace companies this week. Old rails are practically out of the market, and the asking prices for English T rails continues at 26 dols., and double heads at 26.50 dols. Cargo scrap is held at 24 dols. to 24.50 dols. Bar iron is 2.10 to 2.25. Reports to-day from the interior of Pennsylvania indicate an improvement in demand among small buyers who have been holding off, anticipating a reaction. The builders throughout the larger cities say that the coming season will be an unusually large one in house and mill building. A slight decline in prices will bring in heavy orders for rails, rail blooms, slabs, billets, Bessemer, &c.

SELF-CLOSING WATER GAUGE.

THE object of the self-closing water gauge which we illustrate in the annexed engraving, is to prevent the escape of steam and scalding water which takes place when a gauge glass breaks on a steam boiler, and so effectual is it in its action that if the glass be purposely fractured there is practically no outblow. This object is attained by the use of automatically acting valves at each end of the gauge; these valves have their two faces so proportioned that when the pressure is equal at both sides of them, they are firmly held off their seats, but when the pressure is released from the glass they are immediately closed and stop both ends of the broken tube.

The details are clearly shown in the view. The valve B carries at the back of it a piston which has ample clearance round its edges for the circulation of steam and water. It is mounted on a spindle which can slide endways, and as one face of this valve is less than the other by the area of this spindle, it follows that when both sides are exposed to the



same pressure, the valve B will be lifted from its seat, and the valve C driven home. In the first instance, one of the valves B must be opened by hand, and then the pressure will pass through the gauge glass and open the other. Blowing-off is effected through the valve D, which can be ground at any time.

This gauge is the invention of Messrs. Lauderhohn and Nelson, and is manufactured by Messrs. Llewellins and James, of Castle Green, Bristol.

DOUBLE-TRACK ONE-ARMED DRAW.

WE reproduce, on page 134, from our contemporary, *The Railroad Gazette*, engravings of an interesting example of a one-armed drawbridge on the Staten Island Rapid Transit Railroad, designed by Mr. Alfred P. Boller. Our contemporary describes the bridge as follows:

"In these days of great bridges, small ones are apt to be passed over as not worthy of study, and yet the great multitude of bridges are small ones, and in the aggregate they are yet far more important, as respects good design of details, than their larger congeners. This is more particularly true of drawbridges—a nuisance at best, and more or less of an anxiety to any railroad that is forced to use them. On the coast and along the lakes of the United States are multitudes of small waterways crossed by railroads that must be kept open, even if used only by a single daily oyster shallop. Such openings run all the way from 15 ft. to 40 ft., and have called into existence a class of cheap drawbridges, composed essentially of a pair of girders, pivotted at one end and supported at the other by means of rods attached to shear poles or other framework, spread for passage of trains and guyed back to the permanent work on the pivot side of the girders. In many, if not in most of these bridges, the girders fold back on each other (hence the term 'jack-knife draws'), which prevents the use of diagonal and lateral and transverse bracing, or of cross-ties—hence a lack of unity and rigidity ensues, dangerous to high speeds.

"In all such bridges the end thrust on the lower pivot and the cross pull on the upper pivot are very great, and numberless devices have been tried 'to reduce' the friction and ease up the working of the draw, with varying success. There are very few but require a good deal of tinkering or which get along with less than two men to operate them, if of any size.

"The design now illustrated is intended to obviate these difficulties by affording an easily worked and simply detailed double-track draw for a 40 ft. water-

way which shall be well braced and durable. It was designed and built by Alfred P. Boller, of New York, for the Rapid Transit Railroad Company, at Port Richmond, Staten Island. It is easily operated by one man, and the parts were designed with the particular purpose of reducing friction and repairs to a minimum. The girders are in pairs under each track, each pair being braced together with the usual diagonal bracing, the track being supported on cross-ties. The pivot end of the girders consists of a hemispherical cast-iron pivot 5 in. in diameter, while the upper pivot, to which the rods supporting the free ends of the girders are attached, is of wrought iron 5 in. in diameter, forged with a crosshead. The pivot bears against the sides and bottom of a brass-lined cast-iron socket, securely fitted to the heads of the shear poles, to which castings the anchor guys are attached.

"The operating pinion is in the centre between the tracks, and throws either wing out to the left and right respectively by means of the gears and rack segments attached to the ends of the girders. The free ends come up on a pair of sheaves attached to the permanent work, and the tracks are locked by an ordinary lever device, operated by the draw tender, near the turning handle. The permanent work is all wood, the pivot piles and platforms having been put in with the greatest accuracy, and securely braced to the approach trestles and the up-and-down fenders. The anchor piles are of oak, driven as shown, and so spurred into the permanent work as to produce no appreciable cross bending on the piles.

"It is of the utmost importance in bridges of this character that the axis of the upper and lower pivots should be maintained in its true vertical relation, during all positions of the girders, which can only be done through an unyielding permanent work, which, when of wood, must be effectively braced in all directions and no false economy practised in saving a few piles. This seems to have been the aim in designing this structure, the drawings of which are so complete that any more detailed description seems hardly necessary."

NOTES FROM SOUTH AFRICA.

TO THE EDITOR OF ENGINEERING.

SIR,—A party of British senators having just left this part of the empire, after a hasty scamper to the centres of the diamond and gold fields, with a brief glance at the rapidly improving port of Durban, it will be well to supplement the reports of Messrs. Barbour, Kimber, Clark, Cunliffe, Brookes, and Morgan, by a few memoranda on our progress up to date. It is gratifying to state that our Parliamentary visitors appear to have formed pleasing impressions of the country, and have expressed their conviction, that it is intrinsically well worth the cost and time in reaching it, by any of the beautiful vessels now plying to Cape Town; some of which are being made still more comfortable for fastidious and critical voyagers by the fitting of triple engines.

Mr. Kimber being associated with a scheme for emigration, has visited the Free State, and his suggestions to the little commonwealth have been well received at Bloemfontein. The letter embraced hints on irrigation by dams, borings, and weirs, also advocating the early construction of a trunk railway, the latter idea being pressed forward by the Bayonian merchants, who think the time is favourable for the extension of an economical line from Colesberg (near the Orange River), through the Free State to Potchefstroom, which is a central point in the richest section of the Transvaal. The projected railway would afford easy access to the rapidly expanding goldfield at Witwatersrandt, which is likely to equal, if not to surpass, the famed De Kaap fields. Its position is very salubrious, and the reef formation is peculiar and unique, combined with easy access by the miner.

A town is rising with the rapidity of Leadville or Denver, and your humorous correspondent, who recently depicted Colorado, might render the like service to our mining centres in the Knysna, Heidelberg, Piggs Peak, Barberton, Malmani, Fougosi, and the Tugela, all of which will show large camps within six months. Barberton already reckons 12,000 people, with Eureka and Coasts Banks, hotels, schools, chapels, churches, a theatre, hospital, and municipality, for which a town house, with lofty clock tower, is rising, bricks costing 80s. per thousand. An influx of Australians and Californians is expected, and will be welcomed, so as to counteract the oppressive Dutch element, which is a clog to progress. It is hoped that the energetic and favourite Judge Kotze will soon be elected President, and under his rule matters must mend, as he is *au fait* with modern ideas and ways. The present chief, Kruger, an unsophisticated farmer, is utterly unsuited for the post, which is a mild form of speech-house.

The Malmani field lies in Bechuanaland, but is not shown in Bartholomew's Pocket Atlas, which needs additions about Kimberley, and the railways considerably extending. Corrections can be made in the next addition. It is a neat, compact, and valuable production, which will favour the study of geography, now that steam hoists its flag everywhere, and "the horn of the engine is heard o'er the hill." Your readers will be glad to know that it is deemed most important to push forward a railway beyond the Vaal, so as to check a menaced deflection of trade *viâ* Delagoa Bay across the Lebombo Mountains. Negligent and dull statesmen having allowed that splendid sheet of water to rest in the hands of inert Portugal, its development imperils the welfare of Natal, which has again suffered the gravest injury, by the cruel and insane cession of Zululand to our bitter enemies the Boers, who practically defied our authority in that unfortunate country, which has been vivisected by its hypocritical ministerial guardians.

The Boers have established a republic without protest, are allowed political equality at Maritzburg, and now strive to seize Swaziland, where we have just appointed a competent resident. Their conduct is that of pure filibusters, and although attended by many outrages and atrocities, it is indorsed by the British Government, which prohibited English settlers from entering the territory long ago. Thousands of splendid farms reward the audacity and brutality of the invaders, who manifest utter contempt of the law-abiding Englander, whose demonstrations are alike puerile and intensely ludicrous to the rough land grabbers. In self-defence Dr. Clark, M.P., urges Natal to push on her line from Ladysmith to Dundee, the coalfields and factories; all things now favouring economical construction, as steamers of 16 ft. draught, can discharge at the Durban Wharf, the bar having been nullified and obliterated by engineering works, under the guidance of Mr. E. Inness, M.I.C.E., the adviser of the Harbour Board, which contemplates simple operations for rendering Durban a port of the first class, pure water now being in profusion, and excellent coal superseding Welsh on the railway and tugs. The Umbilo reservoir in the hills lies about 500 ft. above the shipping, and gives a splendid service. Natal is rapidly increasing her exports of tea, maize, arrowroot, and sugar, much of the latter coming from Umzinto by steamer. It is hoped that the diversion of sugar beet in Germany to the feeding of cattle, will improve the prices of cane sugar, and help to crush the beet shoddy.

Sugar is now grown at St. John's, which promises to become the port of Pondoland, and to furnish work for engineers. It is thought that cane can also flourish near East London, which already produces coffee and pine-apples. Sorghum has not yet been tried much, but as it yields plenty of sugar by the diffusive hot-water process, and is found splendid food for hogs in Louisiana, it may come to the front, as the porcine tribe is calculated to figure boldly in Kaffraria, now boasting a surplusage of potatoes, maize, and wheat, which do not pay for transport, as railway rates are framed to choke off traffic, so merchants patronise the steamers.

Considerable discussion has ensued upon the export of beef and mutton by refrigerators, but the growth of mining and rising prices will be repressive to this project. The improving wool demand also checks slaughter, and merinos do not suit the abattoir well.

Reservoirs are now replenished everywhere, and the nearly completed dam at Balassi, will give a rowing space for three miles, to King William's Town.

Near Queenstown Mr. Ella has made a third survey for the branch railway to the Indwe coal mines, 40 miles, and reports a favourable route. This line may go forward to Umtata, and end on the St. John's River, where naval vessels might coal in still deep water. A Simond's dredger would render the harbour accessible to vessels of 20 ft. in three months, as the inner channel is deep for 10 miles, and the bar is normally easy.

Stormberg coal is now freely used on the Border Railway to Aliwal North, and it improves as the adits advance. Mr. Tilney, the locomotive superintendent, has adopted grates to suit it. Should the Natal extension from Elands Laaghe, across the Biggarsberg, follow the latest route surveyed towards Dundee, a branch line will be made from the pits, and the working expenses be reduced 50 per cent. by the cheap fuel, which a company with 20,000*l.* capital is ready to furnish. A right decision in the battle of the routes is, therefore, of high importance to Durban, which hopes to become a great coaling port in two years hence, when her facilities should be fairly developed and demonstrated to shipowners.

Steps are also to be taken to protect vessels approaching the Aliwal Shoal, where the s.s. Nebo struck about four years ago with rails and sleepers, thousands of the latter drifting to Durban, by the Bluff, giving a useful testimony to the currents inshore. To mark the coming Jubilee, the Natalians propose an outdoor statue of the Queen for the square before the new and stately town hall. The figure and accessories may be of bronze, from Mr. Bruce Joy's studio, London, but the marble can be quarried near Durban, and the granite for the base and basins from the Paarl, beyond Cape Town. The same artist has prepared a model for the Huguenot memorial in this colony, and his statues by the Mersey are much commended by the cognoscenti. He has studied in Rome and Munich, his chisel recalling the touch of masters of the mallet. Some of your readers will have seen his busts of Gladstone, Bright, Salisbury, and Savory.

To commemorate the year, Cape Town also projects a town hall to cost 50,000*l.* Plans do not seem to be prepared, but excellent granite lies two miles away beyond the Molbeno Reservoir, and there is good near Wynberg; whilst bricks are cheap on the outskirts of the city, which sadly needs a sound system of drainage, and several "Fryer destructors;" as it is now repugnant to sanitarians and scientists. The railway is not yet made to Simon's Town, but a short line is about to be built to Sea Point and Camp's Bay, which are badly served by horse tramway. The competition will soon compel a new track, worked by steam, probably on the fireless plan, as in Java and by the Seine. Near the proposed terminus, a vein of manganese has been found, and samples have gone to London. No steel has yet been made in South Africa, as at Dunedin, where rails can be turned out; but as rich ores exist near Dundee, it is possible that a Bessemer converter may be seen in that quarter—"it is only a question of time"—and ship plates be quoted, as at Sydney, New South Wales. The Cape Breton, Sydney, confines itself to pig iron we think. Our only railway in progress at present is that between Worcester and Robertson, about 25 miles, which is now under inspection by Mr. Elliott Cooper, of Queen's Gate, Westminster. The few bridges and a three-span viaduct, are of Belgian iron, showing how the Britisher is being superseded by the ubiquitous foreigner, for our offices are full of Teutons and our ships of Scandinavians, Danes, and Fins, who are safer and speedier than our sottish seagoers. The mines of diamonds and gold continue to exhibit great steadiness in the world's markets, whilst the feather trade is ready to adapt itself to the peculiarities and tastes of fluctuating fashion, for the ostrich farmers are preparing a magnificent robe of the finest plumes for Her Majesty.

The Inca chief, Atahualpa, wore splendid feathers, but our Empress will quite outshine that monarch, as the present promises to be exquisitely beautiful, and will be prepared with great skill in London. Several batches of ostriches have recently been sent from Natal to Galveston for Los Angeles, California, and to Zealandia; but Africa is the chief habitat of this curious biped, which yields a good return when well managed, although great heat causes its death. Childish legislation has prohibited the export of Cape ostriches, and of the full eggs, which have caused a strange accident in America to a physiologist, at a college, by explosion. Another serious loss to this colony is the absolute exclusion of plant life, except seeds. The preposterous edict was due to the scare about the phylloxera, whilst the ignorant Dutch legislators attributed scab in sheep to the Divine will, and therefore not to be combatted. The microscope and diagrams have, however, taught some that it is a propagating pest which can be extirpated, but the native farmers are quite heedless about this fearful plague of the poor sheep, and allow them to spread contagion *ad lib.*

We have to-day heard of the wreck of the barque Forest Grove on the Bird Islands, 30 miles east of this port, and known in charts for the loss of the Doddington (Indiaman) nearly two hundred years ago. About sixteen years since the s.s. Westenhope was lost there. The group lies low but has a fine lighthouse. The tugs Jos Searle and Paterson went out, but the vessel had disappeared, the crew escaping. Port Alfred lies some 30 miles further east, and has just been visited by the premier, Sir J. Gordon Sprigg, who was impressed by the excellent features of the River Kowie and the unfinished sea walls, which a few years ago were being made in a manner that would have imperilled the safety of any engineer at Cyrene, Carthage, or Sidon, and caused constant protests in the Albany press. All is now abandoned *pro tem.*, and the convicts transferred to Cape Town. A paddle tug proceeds eight miles up the Kowie, which resembles the Dart in scenery. Its neighbour, the Buffalo, is less fortunate as an engineering job, and the peripatetic entrepreneur and impresario never receives benisons, being impaled in print incessantly, and anathematised for his concrete arm on the *wrong* side, so that the estuary is a sand trap. All local critics condemned it *ab initio*, and the results justify their fears and predictions. Much laughter has been caused by statements that a Dutch dredger sent out to operate, on the Ball-Bazin system, was rapidly cutting a channel, for the port remains practically "*statu quo ante* Lucilla," although some good has been effected. East London, however, demands a hopper dredger, and regards the present machine as little better than Mrs. Partington's mop, after being taunted with the half-million fruitlessly wasted. When noting the plans for improving Napier, and seeing the Jumna discharging a heavy cargo at Brisbane Quay, the contrast is discouraging and humiliating to Kaffrarians, who view their fine territory blockaded by fatuity and apathy. To attract sea traffic, the Buffalo Boating Company have reduced landing rates, and much mining material will pass through their hands. The country has an unlimited capacity for producing maize, and the finest wheat and barley can be grown around Queenstown and Cathcart.

Mr. Arnold White's "Wolseley Settlement" is now unsupported. Mr. White made a visit there not long ago, and also traversed Albany, but went back precipitately to England without seeing our splendid Gamtoos River Valley, where the farmers desired an interview. It is said that this fine stream can be made navigable at a small cost by simple works at the mouth, but no disciple of Captain Eads has examined it, and we cannot employ experts of the Coode school. Coal is suspected up the valley, which is famed for fertility and easy irrigability, also for excellent horses, and freedom from animal diseases. It overlooks the Bay of St. Francis, and produces vines, lemons, oranges, silk, and tobacco freely. As the Welsh are now seeking settlements, and have started a railway on the Rio Chuba Patagonia, they might send a deputation here, which would find a rival vale of Dolgelly, and plenty of land on very easy terms. We have Welshmen here, and a warm welcome is certain. Those with a turn for mining can be landed in the spacious Knysna Harbour, which is visited by ocean steamers; the Artos (lately wrecked on the American coast) having 2000 tons, discharged cresote, powder, and dynamite there for the gold fields.

One of our local capitalists, a Mr. Jones, in making a survey of the Knysna diggings, where stampers are worked night and day by steam, giving good returns. The adjacent districts of Cango and Oudtshoorn are celebrated for brandy, bamboos, fruit, and tobacco. The region being a little Tyrol, has a crisp air, also useful thermal springs, and the miners say the mosquito is unknown at Millwood, and only the drone of the sleepers is heard. The creosote works at Knysna are very active, and will entirely exclude soft Baltic sleepers. The machinery came from Rochdale, and works well. Many elephants are in the forest, but without Indian animals and mahouts it is useless trying to catch them. Elephants are sometimes seen crossing the line about thirty miles from this port, and they travel in troops. Horses display great fear of them. Occasionally they are killed by small cannon on farms, and we once bought a small one of 25 lb. *ex utero*, which may be seen at the College of Surgeons. Brass harpoon guns are used here for shooting

whales, but the cetaceans are now off the South Pole, where Professor Ball, of Dublin, advises the Dundee people to follow them, for Captain Ross's vessels reported many there some fifty years ago.

Our Melbourne friends support this idea with eagerness, and promise tourists for the trip to the Antarctic, starting from Otago finally. Our local fisheries have not advanced beyond steam trawling, chiefly for soles, which are fine and abundant. Fish is sent by rail to Kimberley in thirty hours, and when packed with borax, salt, and slabs of ice, arrives in perfect order. Sir J. Maitland's books on pisciculture may promote fresh efforts with trout ova, but we cannot emulate Tasmania and Zealandia with salmon eggs. The seas around the Cape peninsula are, however, cold enough for the herring, shad, cod, and ling. Some of our inland waters may suit the white fish, and an elevated dam is to be made at Cradock, which will be clear and cold. More welded pipes have come here again, and probably went to Kimberley. They are from Birmingham, like the large ones sent to Sydney and Melbourne. Messrs. Berg Brothers have been very successful in boring artesian wells around Burghersdorp, and it is said that the diamond drill has tapped water at 350 ft. on the Karroo, beyond Beaufort West. It is believed that plenty of potable water lies under this drift formation, and Mr. F. Weston, from Melbourne, representing an American boring company, is now in Cape Town, offering to drill on liberal terms. We have not yet struck oil like M. Arbay at Clermont Ferrand; but it is surmised that petroleum exists in the colony. In Algeria, borings of 60 ft. usually give ample water; but farmers here think 20 ft. very deep, and grudge the cost of going further, although some have flowing wells at 70 ft., which have trebled the value of farms, and protect against drought. Our skilful veterinarian, Professor Hutcheon, travels through the colony, and is admitted to be an invaluable servant of the Government. The wine expert, Baron Von Babo, has had a severe accident, being thrown against a tree, and the tobacco expert, Von Schenek, has done little, not being able to speak either English or Dutch. A capacious wine depôt has been formed here, and is open to strangers. It is managed by a skilled expert, and the wines under manipulation and maturation are all prepared on Von Babo's methods, so are sound and pure. Lists will be sent on application to Mr. W. Hume, the manager of the Association, Market Hall, Port Elizabeth.

Much attention has been excited by the capsize of Lancashire lifeboats, as we have Southport men here. Our boat is a "Forrest," but not self-righting. It is only used on a vessel beaching, and behaves well. East London has one with an iron keel, and when it got adrift some years ago it often rolled over in the fearful surf, happily drifting back to the starting point, only slightly damaged. The coast there is open, and vessels require good tackle for holding. Port Alfred is equally exposed to rollers, and it has a bold landmark 850 ft. high on the south side, the railway rising 1700 ft. in 40 miles to the Settlers' City, where it is proposed to hold an exhibition, as the place is reviving, and has good English society, musical meetings, a museum, baths, good hotels, a cathedral, botanic gardens, artillery corps, and many sporting facilities. We find also a foundry, wagon work, observatory, and superior shops of all kinds, besides boot, candle, jam, and carriage factories.

We have not yet started blanket and tweed works as in New Zealand and New South Wales, but they are discussed, having been in operation about thirty years ago in Albany. The cultivation of cotton advances slowly, and the natives take an interest in it. Tobacco and cigars are also being produced of a good stamp by Mr. S. Amur, Salem. Some farmers are sending their orange crops to Kimberley, with satisfactory results. This season the cereal and grape crops will be unusually prolific, and attempts will be renewed to ship grapes and peaches in cork dust, which the Union Company has conveyed free to Cape Town, to promote the enterprise. There is no doubt that this colony may in time rival California in the raisin trade, and peaches and apricots are grown profusely. With a little encouragement raw silk could be exported on a large scale, as the finest samples have been shown, and the mulberry tree grows everywhere to a good size on the coast line. In Persia, silkworms thrive at 6000 ft., and every villager rears them.

These staples require mechanism, and therefore are allied to engineering, which enters largely into the operations of modern agriculture, and when the farmer prospers his twin brother the engineer will be to the fore with pumps, presses, ploughs, and other paraphernalia provided by science. A beneficent stimulus of every kind may be reasonably expected from our expanding auriferous zones, and their development must materially assist in the revival of prosperity in the remotest parts of civilisation by relieving commercial congestion. Mrs. Craik has sent a pleasing Christmas card to the colonies, the keynote being "English yet." We are indeed more English in sentiment than those who stay at home and vex our souls deeply by stubborn prejudice. and dangerous stupidity in matters of moment. The British patriot, as a pioneer, demands every sympathy from the home country, but often gets ignorant disdain and contumely. We can, however, dispense with England, much better than she can afford to lose our support, and more frequent trips to the colonies by your junior merchants and upper classes will dispel many delusions, besides cultivating trade and the sentiments sung by Tennyson—

"Every grim ravine a garden, every blazing desert tilled,
Robed in universal harvest, up to either pole she smiles,
Universal ocean softly washing all her warless isles!
Only That which made us, meant us to be mightier by-and bye,
Set the sphere of all the boundless heavens within the human eye."

With reference to the poet's astral speculation, whether or not the people in Venus regard with envy "this globe we groan in," as the abode of peace, plenty, and light, we can now affirm that we have a prospect of the first, despite the slaughter at Uganda, and the other items are assumed. Our railway transport is nearly on a par with the Sybaritic steamers, and the cars run smoothly and safely, through sunny and sometimes through charming and strange scenery, attractive to botanists, geologists, and artists, though lacking the grandeur of Tenerife and Orotava. We know not earthquakes and eruptions, whilst the favours of Aquarius have clothed the plains and hills with verdure and perpetual flowers. Afric's sunny fountains do often roll down golden sands, so the invalid and the *blasé* tourist can equally reckon on benefits by coming to see our lions.

Yours, &c.,
P. FRANCE.

Port Elizabeth, January 17, 1887.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—After eleven days of continued depression, last Thursday's warrant market showed a certain degree of buoyancy, accompanied with a recovery of prices. There were numerous purchases, and the price of Scotch warrants at one time got up to 44s. 9d. per ton cash, being an advance of 6d. from the previous day's close, and 10d. per ton for the lowest quotation on Wednesday; the final quotation, however, on Thursday was 44s. 5½d. Cleveland warrants closed at an advance of 4½d. per ton, and hematite warrants were 9d. per ton better than the finishing prices on the preceding day. In the expectation that the miners were going back to their work on Thursday, the prices of pig iron were less buoyant in Friday's market. Scotch warrants declined to within 2½d. per ton on Wednesday's lowest quotation, and 7½d. under Thursday's lowest. In consequence of the continuance of the miners' strike, however, a partial recovery took place, and the closing price of Scotch iron was 44s. 3½d. cash, being a decline of 8½d. on the week. On the price of Cleveland iron there was a decline of 3d. per ton over the week, and in the price of hematite warrants the day's decline was 7½d. per ton, making 1s. 7½d. over the week, the closing quotation being 48s. 1½d. cash. The special brands of Scotch iron all gave way considerably in value during the week, in some instances to the extent of 1s. 6d. per ton; and the quotations at the close were, Coltness, 57s.; Summerlee, 56s.; Langloan, 54s.; Gartsherrie and Calder, 62s. per ton. After the opening of the market on Monday, prices soon ran up 6d. per ton, owing in great measure to the likelihood of the miners' strike leading to the damping down of some of the blast furnaces through want of coal. Later on, the tone of the market became rather depressed when it was known that the past week's shipments had been low, and part of the early gain was lost. At one time Scotch pig iron touched 44s. 10d., but the closing price was 44s. 5½d. cash per ton. Cleveland warrants at the close stood at 36s. 5d., or 2d. under the best point; and hematite iron, which rose in price to 48s. 10½d., closed at 48s. 9d., being 7½d. better on the day. The miners' strike again caused some excitement in iron circles on Tuesday. Prices were decidedly firm, and further advances were made—Scotch warrants closing at 44s. 8d. per ton, Cleveland warrants at 36s. 7½d., and hematite warrants at 49s. 3d. All sorts of pig iron have declined in price to-day. At the opening of the forenoon market business was done in Scotch warrants at 44s. 8½d. per ton cash, and at the close buyers were offering 44s. 6½d., with sellers at 44s. 7d. cash, and by the close in the afternoon the decline had reached 44s. 2d. buyers and 44s. 3d. sellers cash. Cleveland and hematite also declined in price to a considerable extent. The number of blast furnaces in actual operation is now 74, as compared with 94 at this time last year. One was put out during the week at Shotts Iron Works, and one at Eglinton, while an additional furnace was blown in at Summerlee. Of those in blast, 50 are producing Scotch iron, 6 are making basic pig iron, and 19 are working on hematite ironstone, of which material 33,438 tons were landed in the Clyde from 27 steamers last month. Last week's shipments of pig iron from all Scotch ports amounted to 5667 tons, as compared with 7988 tons in the preceding week, and 5621 tons in the corresponding week of last year. They included 1315 tons to the United States, 185 tons to India, 280 tons to Italy, 150 tons to China and Japan, and smaller quantities to other countries. Upwards of one-half was sent coastwise. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores yesterday afternoon stood at 842,169 tons, as against 842,603 tons yesterday week, showing a decrease for the week of 434 tons.

The Coal Trade.—The Scotch coal trade still remains in a disorganised state on account of the miners' strike, the position being rather intensified than otherwise during the past week. In the Blantyre district, near Hamilton, very serious and disgraceful riots have occurred this week, necessitating the calling out of strong bodies of police and cavalry soldiers. There are still a few collieries at work in the troubled districts, the output of which has gone a long way towards keeping an actual coal famine from resulting. In a number of instances prices have been advanced to the extent of even 2s. 6d. per ton or more, but this policy on the part of coalmasters has had the effect of checking sales very considerably. During the past week the advance of wages sought for by the miners has been conceded at a number of additional collieries.

New Steel Works.—A new local concern for the manufacturing of steel is being promoted under the title of the Renfrew Steel Company, Limited, with a capital of 250,000*l.*, of which only one-half is to be called up in the first instance. Some gentlemen connected with the Greenock and Port-Glasgow industries are said to be amongst the leading promoters of the concern, and negotiations are in progress for the acquisition of a suitable site for the works, extending to from seven to ten acres, from the Renfrew Town Council. Special facilities are guaranteed to the new company by the River Cart Improvement Commissioners. It is understood that the prime mover in the scheme is Mr. Lindblad, a Swedish engineer, who was employed for some time in one of the large steel establishments at Sheffield, and was subsequently in the employment of the Steel Company of Scotland. The intention of this new company is said to be, in the first instance, to devote special attention to the production of steel castings, such as are in demand in shipbuilding and engineering work.

New Bridgebuilding Works at Dalmuir.—Mr. Peter A. Somervail has begun to lay down the foundations of large workshops at Dalmuir, where he intends to carry on the business of steel and iron bridge, roof, and girder building. The ground on which the works are to be built is three acres in extent, and is very conveniently situated between the North British Railway Company's Helmsburgh line and the Forth and Clyde Canal. The workshops will consist of two sheds placed at right angles to each other. The larger is to be 283 ft. long, and the smaller 50 ft. long. The greater portion of the machinery will be in these sheds, that in the large shed being driven from a line of shafting along the outer wall, and all the machine work, except rivetting, will be carried on there. Besides these there will be another building 70 ft. long and 35 ft. broad, the floor of which will be used exclusively for drawing, and there will also be provided a large and commodious suite of offices. A large portion of the machinery has been ordered from Messrs. James Bennie and Co., Polmadie, Glasgow. The engines for driving the machinery will be of the high-pressure horizontal type, made by the well-known engineers, Messrs. Turnbull, Grant, and Jack, Canal Basin Foundry, Glasgow, and will be fitted with Mr. Jack's new valve gear. It is expected that these works will be completed in from three to four months. Dalmuir is quite close to Clydebank, where Messrs. James and George Thomson's extensive shipbuilding and engineering works are situated, and to the great sewing machine works of the Singer Manufacturing Company at Kilbowie. This district bids fair to become an important seat of manufacturing industry.

Lerwick Harbour Works.—For the extension and improvement of the works under their charge, the Lerwick Harbour Trustees have recently been informed by the Public Works Loan Commissioners that they have agreed to advance them a loan of 15,000*l.*, to be repaid with interest at 3½ per cent. by way of annuity in thirty years, or in fifty years computed from date of security from bank by equal instalments of principal with interest at 4 per cent. per annum. Their desire, however, is to get an additional 5000*l.*, the amount originally asked having been 20,000*l.*

A New Allan Liner.—It is stated that Messrs. James and Alexander Allan, of this city, the owners of the Allan Line of steamers, have just issued specifications for a new steel steamer of about 5000 tons, with engines of 6000 horse-power. Schedules have been placed in the hands of the leading shipbuilding firms on the Clyde, and it is expected that the contract will be settled in the course of a few days. It may be remembered that Messrs. Allan were the first to venture on building a steamer of steel for the Atlantic service. The vessel referred to was the Buenos Ayrean, which was constructed by Messrs. William Denny and Brothers, Dumbarton. It is understood that this new steamer is to be fitted not only with triple-expansion engines, but also with boilers to be worked on the forced draught principle.

Dundee Mechanical Society.—An ordinary meeting of this Society was held last Thursday evening, at which Mr. John S. Anderson read an interesting and very practical paper on "Pattern-making and Founding," in the course of which he dealt with the antiquity of the two crafts, the qualification necessary for a pattern-maker, a description of the work which he does, the best methods to be adopted in different cases for the moulding of his patterns so as to get them most easily drawn out of the sand, the facts connected with the contraction which takes place in the cooling of different metals, and an account of the method of chilling castings.

Gigantic Factory Engine.—Messrs. Douglas and Grant, Dunnikier Foundry, Kirkcaldy, have at present in hand a compound Corliss engine of a very large description for a cotton mill in Bombay. The high-pressure cylinder of this large engine is 40 in. diameter and the low-pressure cylinder 70 in., each having a stroke of 6 ft. The flywheel, which weighs about 110 tons, is 30 ft. in diameter by 8 ft. 6 in. wide, grooved for 38 ropes, by which the power is to be transmitted to the various lines of shafting in the mill. The engine is to run at 60 revolutions per minute, giving a speed of ropes of considerably over one mile per minute. The crankshaft, made of Whitworth fluid compressed steel, is 25 in. in diameter in the body and 20 in the bearings. The steam pressure is to be 100 lb. per square inch, and the engines will work easily up to 2500 horse-power.

BUENOS AYRES.—Extensive harbour improvements are contemplated at Buenos Ayres. One of the projects under consideration is a line of inshore docks with an entrance canal. These docks will involve, it is estimated, an outlay of 800,000*l.*

ONE-ARMED DRAWBRIDGE; STATEN ISLAND RAPID TRANSIT RAILROAD.

MR. ALFRED P. BOLLER, ENGINEER.

(*For Description, see Page* 131.)

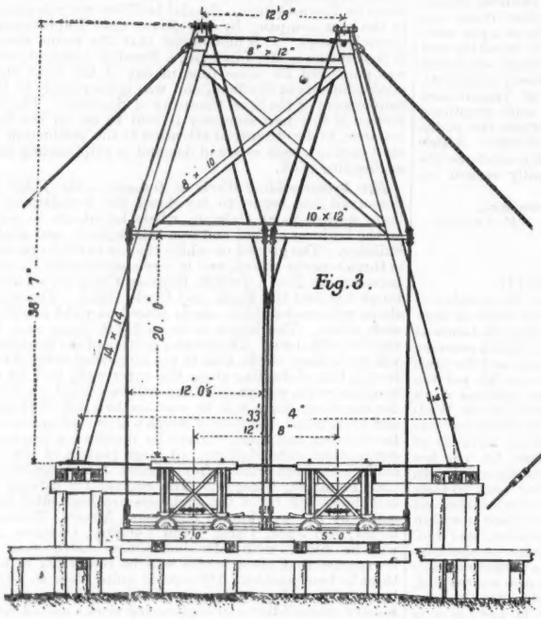


Fig. 3.

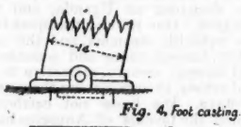


Fig. 4. Foot casting.

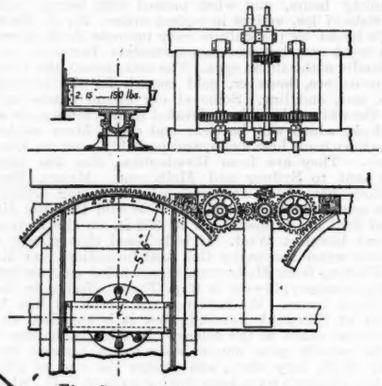


Fig. 5. Gearing & Pivot casting.

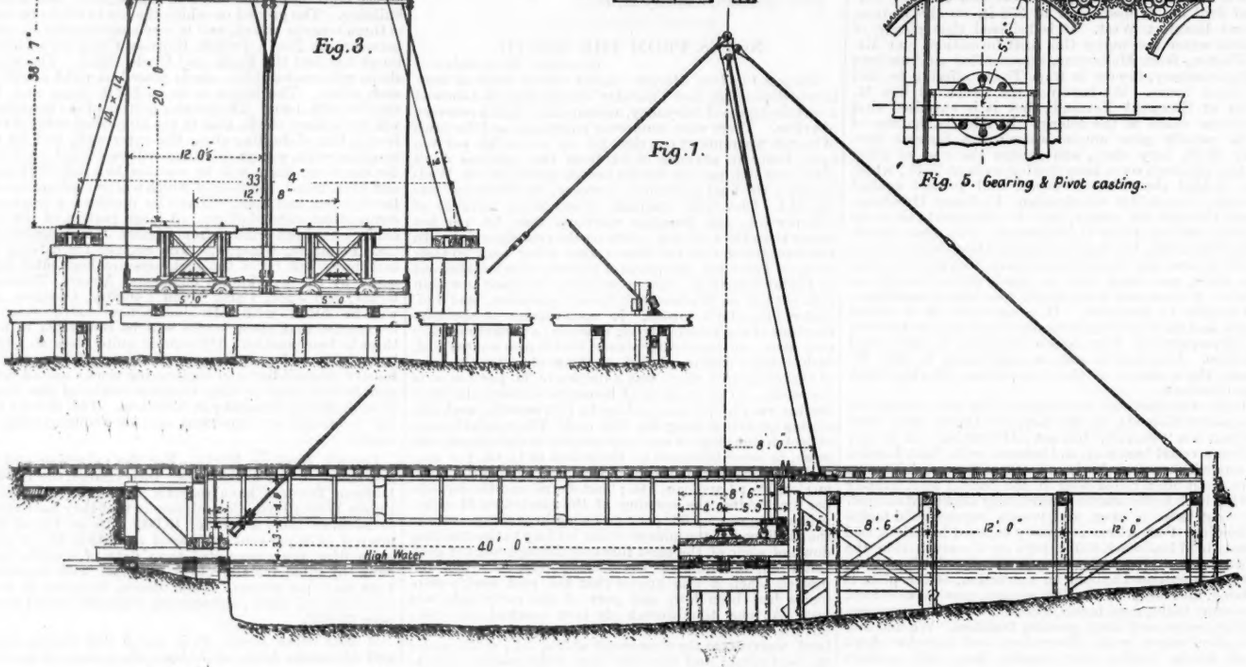


Fig. 1.

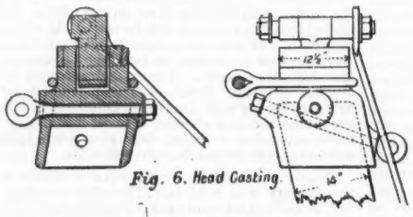


Fig. 6. Head Casting.

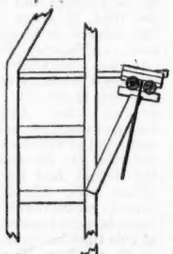


Fig. 2.

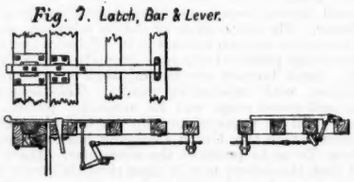
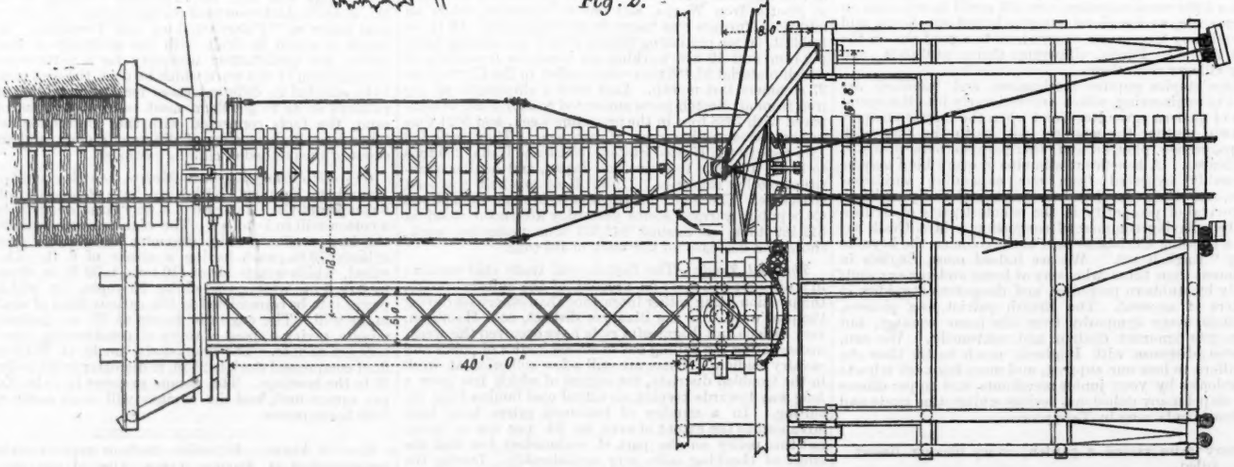


Fig. 7. Latch, Bar & Lever.



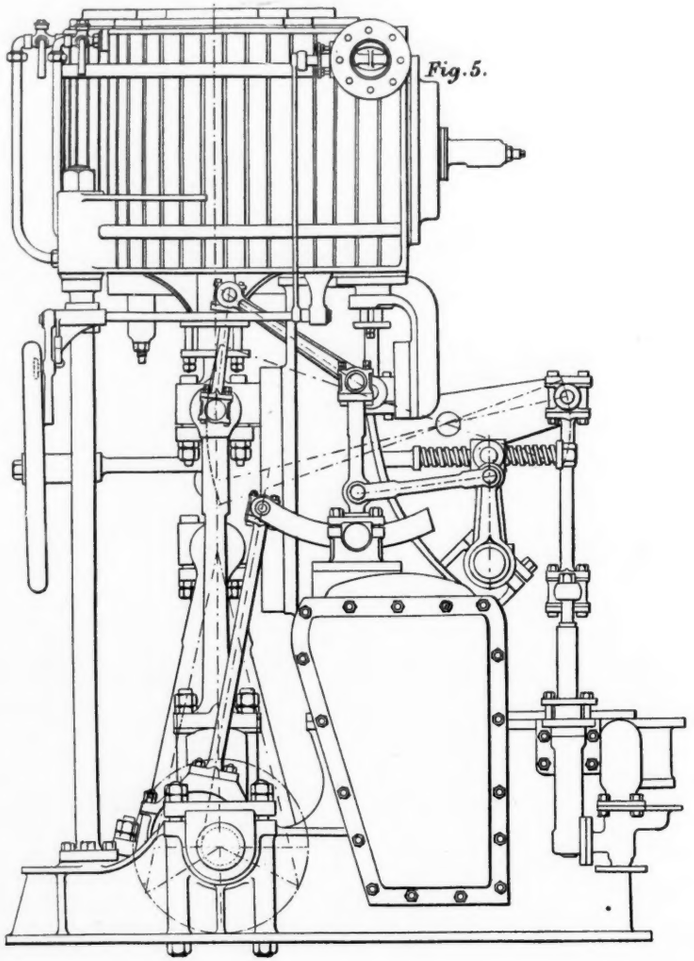
Tramways at Melbourne.—At the yearly meeting of the Melbourne Tramway and Omnibus Company, the directors' report recommending a dividend of 12 per cent. was adopted. The chairman stated that the Brunswick, Collingwood, Carlton, and Nicholson S. T. tram-lines would be ready for opening in six or nine months. The lines already open were working smoothly and satisfactorily. During the year ending 30th September, the company had carried 16,363,850 passengers, as against 11,659,937 in the previous year. The larger number included about 5,000,000 carried on the Richmond tram-line, the only one open at the end of September.

TRIPLE-EXPANSION ENGINES AND BOILER OF THE STEAM YACHT "GLADIATOR."

CONSTRUCTED BY MESSRS. RAMAGE AND FERGUSON, ENGINEERS, LEITH.

(*For Description, see Page* 142.)

Fig. 5.



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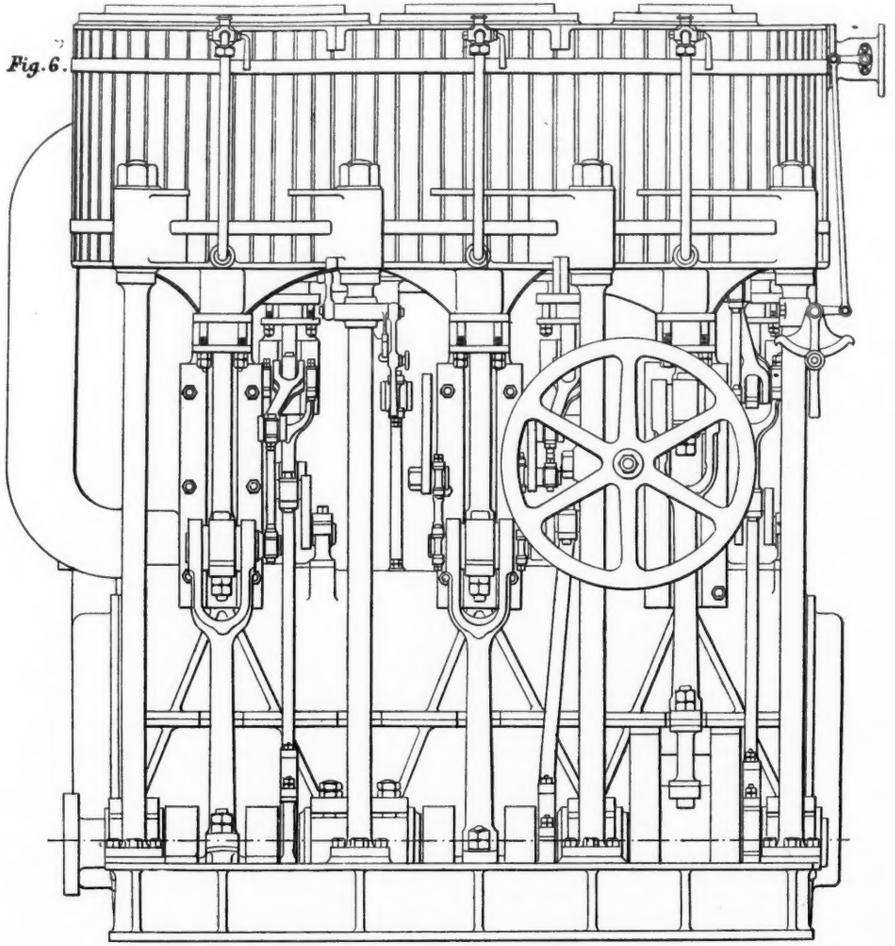
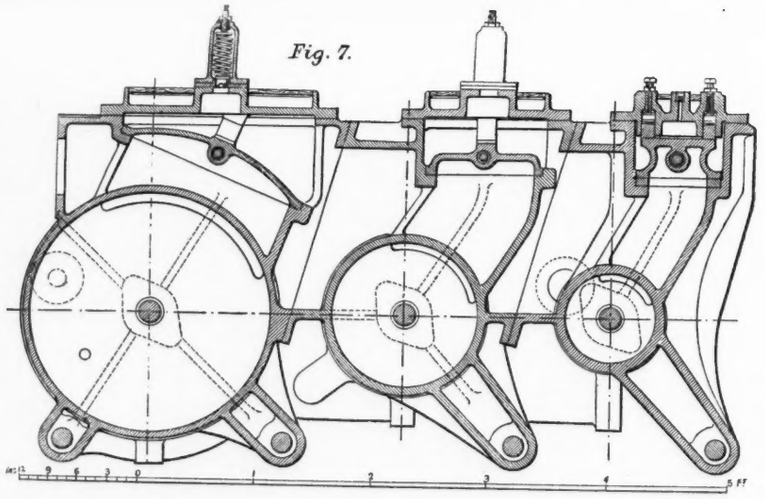


Fig. 8.

Fig. 7.



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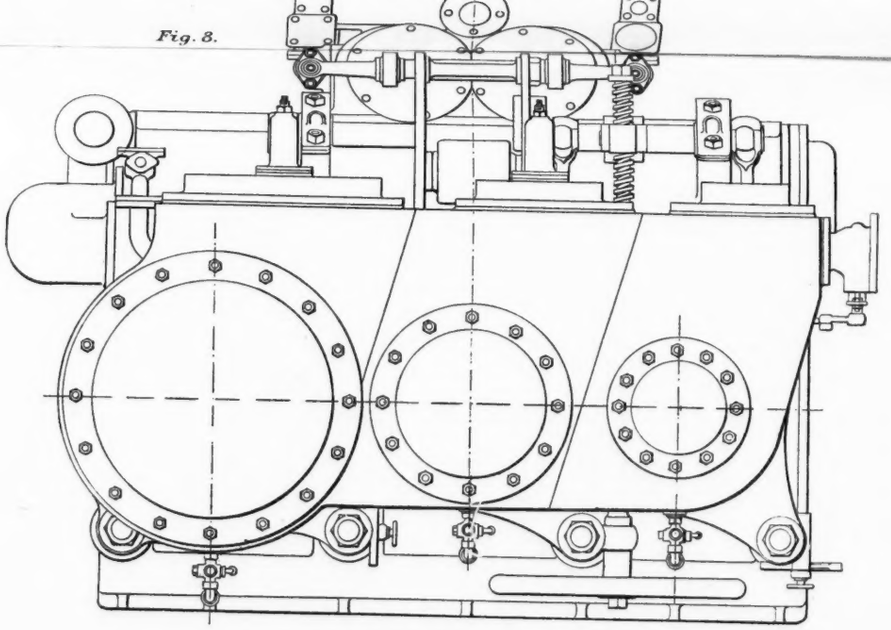


Fig. 9.

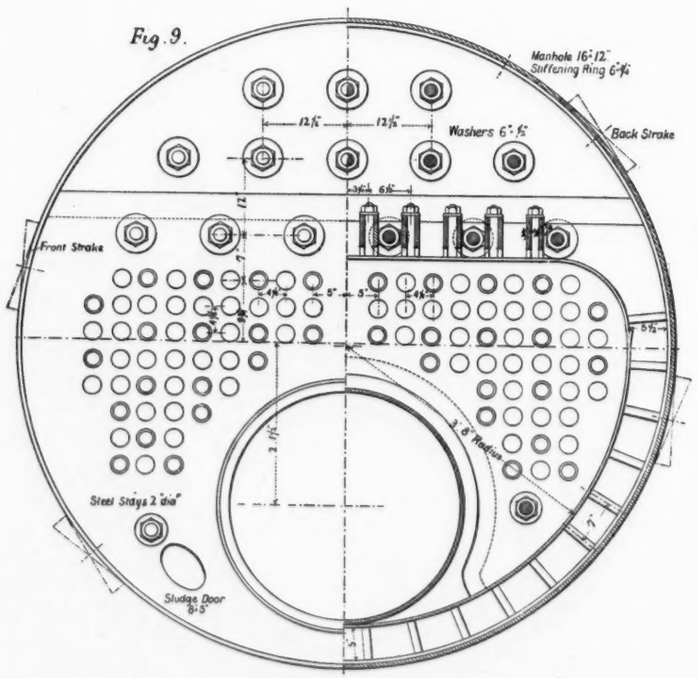
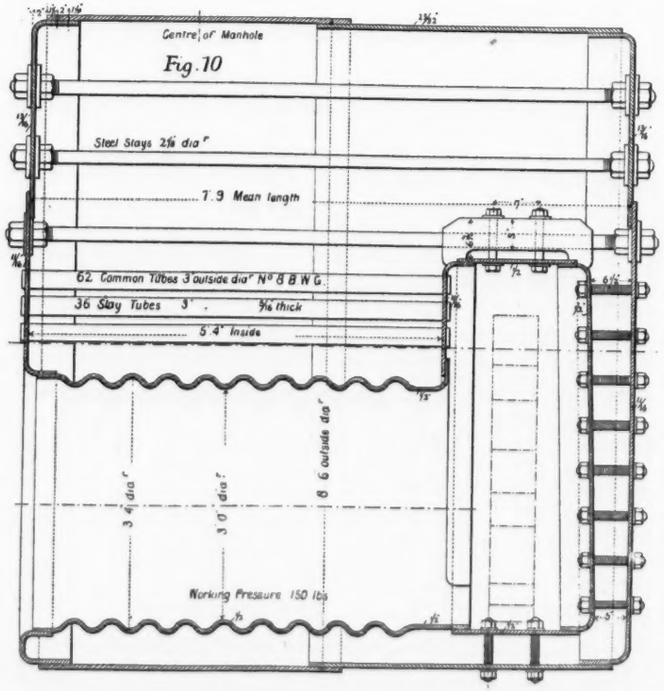


Fig. 10


Centre of Manhole
Steel Stays 2⅛ dia"
7.9 Mean length
62 Common Tubes 3" outside dia" N° 8 B W G.
36 Stay Tubes 3" . ⅜ thick
5'4" Inside
3 4½ dia"
3 0" dia"
8 6 outside dia"
Working Pressure 150 lbs

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With a Two-Page Engraving of TRIPLE-EXPANSION ENGINES AND BOILER OF THE STEAM YACHT "GLADIATOR."

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Ordinary meeting, Tuesday, February 15th, at 8 p.m. Papers to be further discussed: "Sewage Sludge and its Disposal," by William Joseph Dibdin, F.C.S., F.I.C. "Filter Presses for the Treatment of Sewage Sludge," by William Santo Crimp, Assoc. M. Inst. C.E., F.G.S. Paper to be read with a view to discussion: "Irrigation in Lower Egypt," by Wm. Willcocks, Assoc. M. Inst. C.E.—Students' meeting, Friday, February 18th, at 7.30 p.m. Paper to be read: "Diving; the Apparatus used, and the Work carried out under Water," by Geo. A. Becks, Stud. Inst. C.E.

CHEMICAL SOCIETY.—Thursday, February 17th, at 8 p.m. Ordinary meeting.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, the 16th instant, at 7 p.m., by kind permission of the Council of the Institution of Civil Engineers, at 25, Great George-street, Westminster. Ordinary meeting, when the discussion on the Hon. R. Abercromby's paper, "On the Identity of Cloud Forms all over the World; and on the general principles by which their indications must be read," will be resumed, after which the following papers will be read: "Remarks concerning the Nomenclature of Clouds for Ordinary Use," by Dr. H. H. Hildebrandsson, Hon. Mem. R.Met. Soc. "Suggestions for an International Nomenclature of Clouds," by the Hon. Ralph Abercromby, F.R.Met. Soc. "The Influence of Weather on the proportion of Carbonic Acid in the Air of Plains and Mountains," by W. Marcet, M.D., F.R.S., F.R.Met.Soc., and A. Landriset.

THE PARKES MUSEUM, 74A, MARGARET-STREET, W.—Thursday, February 17th at 5 p.m., when a lecture will be delivered by Mr. Charles E. Cassal, F.I.C., F.G.S., public analyst for Kensington, and for St. George's Hanover-square, on "Food Adulteration and Analysis." The chair will be taken by Professor W. H. Gorfield, M.A., M.D. (Oxon), F.R.C.P.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Wednesday, 16 inst., at 7 p.m., at 7, Westminster Chambers, S.W., when a paper on "Reservoir Dams," will be read by Mr. David Gravell, A.M.I.C.E.

ENGINEERING.

FRIDAY, FEBRUARY 11, 1887.

REGISTRATION OF TRADE MARKS.

NOTHING could be more unsatisfactory than the way in which the business of registering trade marks is being carried out under the Patents Designs and Trade Marks Act of 1883. As pointed out by Mr. Edmund Johnson in a recent letter to a contemporary, the growing importance attached to trade marks has led to a steady increase at the Patent Office in the number of applications tendered for registration. The Trade Marks Branch there, has, however, proved utterly inadequate to meeting the requirements of the public. A constantly increasing state of arrear in the examination of, and further dealing with, such applications has resulted. From whatsoever causes arising, it is a serious grievance that an application, no matter how important in its nature, even when no difficulty exists to preclude its immediate acceptance, should in its rotation order meet with a delay of several weeks before being passed for advertising in the official journal. Constant complaints are made, but no practical remedy has thus far resulted. Whilst numerous marks are intended for permanent use, in many industries a large proportion of those tendered for registration are but ephemeral in their nature, being employed in what are known as season goods. The prompt passing of marks coming within this latter category is of vital importance, as the goods have to be shipped in anticipation; while the danger of applying a proposed trade mark, until certain that it has in no way been anticipated, is great, notwithstanding that every precaution may have been taken by searching, to avoid interference with the pre-existent rights of others. Not only so, but it should be noted that the Act provides that a person shall not be entitled to institute any proceeding to prevent, or to recover damages for, the infringement of a trade mark, unless, in the case of a trade mark capable of being registered under the Act, it has been so registered, or has been registered in pursuance of an enactment repealed by the Act; or, in the case of any other trade mark in use before the 13th of August, 1875, registration thereof has been refused. Therefore assuming what is known as a new mark (*i.e.*, one not in use prior to 13th August, 1875) to be adopted and registration thereof to be refused, the owner appears to have no remedy against others who may appropriate his mark for the same class of goods. Considering the unreasonable way in which some applications for registration are dealt with, this is a serious point. Indeed, so erratic and unreliable has been the practice at the Patent Office in respect of trade marks, that we must entirely dissent from the suggestion which has been made, that the only mode of meeting the difficulty above mentioned is an immediate increase of the permanent staff of the Trade Marks Branch. On the contrary, the number of officials employed at the Patent Office is already too large, and the expenses of the department are excessive, regard being had to the useful work done. A more satisfactory solution of the trade marks difficulty would be to place trade marks upon a similar footing to inventions, that is to say, instead of attempting to determine before registration whether a mark is proper subject matter for registration or not, every application made in due form should be advertised, and a simple and inexpensive mode of dealing with cases of opposition should be provided. This of course would involve legislation, but the result to the public in general, and to traders in particular, could not fail to be more satisfactory than the present state of affairs; not to mention the very considerable saving in public money that would be effected.

The examination system as applied to trade marks, like that with respect to applications for Letters Patent, has proved a miserable and costly failure. It does no good; it causes annoyance and injustice; it is misleading, and may be regarded generally as nothing short of a waste of money that might be much more usefully applied. It certainly cannot be defended by any who really desire to economise the public purse. If, as some asserted, the useful and moderate system of preliminary examination of applications for patents proposed some years ago by Mr. Lloyd Wise, and advocated by us, was of a grandmotherly nature; how much more so is the system now in force in regard to trade marks? Let us briefly consider a few facts. To begin with, according to Section 76 of the Act of 1883, registration of a person as proprietor of a trade mark shall be *primâ facie* evidence of his right to the exclusive use of the trade mark, and shall, after the expiration of five years from the date of the registration, be conclusive evidence of his right to the exclusive use of the trade mark, subject to the provisions of the Act. This section was taken from Section 3 of the Act of 1875. Under that Act it was decided that a mark which was not authorised to be registered as a trade mark, could not acquire the character of a trade mark by being on the register for five years, and might be removed from the register although that period had elapsed. The obvious effect is, first, that any trade mark which was not a fit subject for registration will be removed from the register on application to the Court; secondly, whether it has been so registered for less or more than five years; and, thirdly, that while such mark remains on the register the registration confers no rights upon the person in whose name it has been registered. Substantially the same would be true of a patent improperly granted. A large sum is annually spent in searching as to the novelty of marks forming the subjects of applications for registration; nevertheless many marks are registered that ought not to be. It results that public money is wasted, and the applicants for registration are deceived; so are the public. Fortunately the clause in Mr. Chamberlain's Bill that provided for preliminary examination as to subject matter of applications for letters patent was struck out; otherwise disastrous consequences would have resulted. The utter breakdown of so much of the examination system as was retained, its costliness, and its cruelly misleading effects, are in themselves sufficiently serious. But, fortunately, unopposed applications for Letters Patent are not refused for alleged want of novelty, or on the ground that the use of what is described would infringe prior patents. The authorities do not expressly compel an applicant to practically invite prior patentees to allege that the inventions of such applicants infringe the rights of such earlier grantees. But, monstrous as it may seem, that is what is constantly done in the case of trade marks; and a more gross abuse it would be difficult to conceive. We have already stated that there are many marks on the register that ought not to be; yet a manufacturer having devised and adopted a mark, some part of which in some remote degree resembles some mark already improperly registered, may be placed at the mercy of the person in whose name that mark has been placed on the register. It is only natural that a person who has already registered a mark, and who is given to understand, by a Government department, that a later applicant is at his mercy, should (unless exceptionally well disposed and honourable) take advantage of the position in which he is (however improperly) placed. If a man invents a machine comprising parts we will call A, B, C, and D, he will (very properly) be allowed a patent, even though his application be opposed by a prior patentee whose machine comprises parts A, B, and C only. Not so in the case of a trade mark. In other words, if the theory on which the business of dealing with applications for registration of trade marks is conducted were carried to its logical conclusion, a point might be reached at which a trade mark capable of registration would become an impossibility, because it would be composed of lines, or marks, or letters, or figures, or devices that might be found in some shape or form in marks already on the register.

The question of infringement ought not to be dealt with on an unopposed application for registration of a mark. The law provides that every application shall be advertised before the mark in respect of which it is made is placed upon the register. With a proper index, therefore, it is easy for those interested to oppose any application they may think proper to oppose, except that the machinery

now provided is needlessly cumbersome, dilatory, and costly. The authorities in Southampton Buildings go out of the way in many cases to find a pretext for refusing applications. A mark comprising three main parts—say A, B, and C—is not likely to be mistaken for a mark consisting of A alone. But the official idea seems to be that if the combination of A, B, and C were placed upon the register, the owner of it might afterwards abandon B and C and use A alone. A trader so dishonourable might obviously do the same thing without applying for registration; and, indeed, it is difficult to see what advantage he would gain by seeking to register, for if what he desired to protect was A, without B and C, obviously he must fail, assuming A to be properly on the register. What now happens upon such an application is that the applicant is told that before his application can be proceeded with, he must obtain the consent of the person in whose name the mark A stands upon the register. This is absurd and unjust. If any one used a mark so like the one already registered by another person in connection with the same class of goods as to be calculated to deceive, the rightful owner of the mark would not be likely to remain long in ignorance of the fact, and would probably not be slow to adopt proper means for protecting his rights. This is a totally distinct matter from the question whether an applicant is entitled to registration of a mark consisting of a combination only a portion of which bears some resemblance to a mark already on the register. The registered owner of a mark should be left to his remedy just as is the registered owner of a patent.

SEA-GOING TORPEDO BOATS.

All investigations of the sea-going qualities of torpedo boats show that while the basin experiments are highly satisfactory, those made at sea prove with equal force the unreliability of these crafts when they leave the coast. At the beginning of the Milford Haven operations, the boisterous weather necessitated the postponing of operations on account of the unfitness of the torpedo boat crews to continue work after the twelve hours of serious fatigue they had already undergone. In the French evolutions, the difficulties of the passage from Bastia to Ajaccio, although not remarkably severe, so unfitted fifteen of the twenty boats that they could take no part in the final attack. In two nights we find recorded collisions which disabled boats Nos. 52, 61, 63, and 72, and required their return to port for repairs.

Of the twenty-two torpedo boats leaving Toulon a few days before, but six arrived near the enemy, although their commanders displayed admirable energy; one had run aground and was full of water, another had been sunk by collision; another's engine was seriously injured; and, as for the rest, they could not follow. Of the boats under the command of Admiral Brown de Colstoun but five remained for service, for the sixth received an accident to her machinery which prevented her taking part in the attack.

During the operations off the Balearic Isles, only one of six boats attacked, and none were able to follow the armour-clads, all meeting with circumstances quite unexpected and embarassing. With the weather as it existed May 13th, the armour-clads had the torpedo fleet completely at their mercy, for even if they had not been destroyed by the excellent practice of the Hotchkiss gunners, they would have been of no use, as they could not with safety discharge their torpedoes. In fact, the search lights discovered distinctly that one of the boats, which burned her Coston's signal to announce victory, did not have her torpedo tube open on account of the heavy sea. Furthermore, their positions were frequently easily discovered by the immense volume of smoke and flame ejected while going at great speed. This applies as well by night as by day. It was also reported that after the four days' running the speed of the boats was reduced to twelve knots.

With such evidence before us, the seaworthiness of boats of the Nos. 63 and 64 type may be seriously questioned. Weyl emphasises the facts that "practice has shown that boats of No. 61 type cannot make headway in a heavy sea, and that it is then often impossible to open their torpedo tubes. On this account they are greatly inferior to ships of moderate tonnage, which can certainly make some progress, fire their torpedoes and use their artillery in weather when a torpedo boat will be utterly helpless. The torpedo boat abandoned to itself has a very limited field of action."

Du Pin de Saint André admits the success of the torpedo boat for harbour and coast work, but wisely concludes that this can prove nothing as to what they may or may not be able to do at sea. In an article which appeared in the *Revue des Deux Mondes* in June last, he presented able reasons why the torpedo boats of to-day's type, being destitute of most, if not all, of the requisites of sea-going craft, cannot go to sea, take care of themselves, and remain there prepared to attack an enemy wherever he may be found. Invisibility to an enemy may facilitate attack, but it has to be dearly paid for in diminished safety. Further, the life that must be led in such vessels in time of war would very quickly unfit men for their hazardous duties. He points out that the effect of such life upon the bodies and minds of the officers and crew would be most disastrous. The want of exercise alone would be sufficient to unfit them for the demands that service would make upon them. He has intelligently depicted the consequences of such a life, and his reasoning has been indorsed by the reports of French officers who have had experience in the boats in question. No weapon, no matter how ingenious, is of utility in warfare unless it can be relied upon, and no vessel that is not tenantable can be expected to render any service at sea.

From the evidence before us we must conclude that the type of torpedo boat under discussion is capable of making sea passages, provided it can communicate frequently with its supply stations and secure the bodily rest so necessary to its crew. But even in a moderate sea, it is useless for attack, and in the majority of cases will not be able even to open its impulse tubes. Should it succeed in doing this, the rolling and yawing will render its aim very uncertain. An experiment conducted against the Richelieu in October last, at Toulon, before Admiral O'Neil, the director-general of the torpedo service, has added its testimony to the uncertainty of the Whitehead torpedo. The Richelieu had been fitted with Bullivant nets, and the trial was made to learn what protection they would afford. The weather was fair, the sea moderate, and the conditions generally favourable to the torpedo; but the Whitehead missed its mark, although the Richelieu's speed was only three knots. Running at full speed, the torpedo boat, even in this moderate sea, deemed it prudent to keep the launching tube closed, and selected a range of 250 yards for opening it and firing. Just at the moment of discharge a little sea came on board, the boat yawed, the torpedo aim was changed more than 30 deg., and it passed astern without touching its object.

While the Milford Haven operations have taught some valuable lessons, they were conducted under but few of the conditions that are most likely to occur in actual warfare, and had the defence been carried on with an organisation and command equal to that of the attack, the Navy's triumph would, perhaps, not have been so easily secured, and the results might have been very different. May not the apparent deficiencies of the defence have been due to the fact that soldiers instead of sailors are given the control of the harbour and coast defence? Is this right? Ought they not to be organised on a naval basis? This is no new suggestion, but its importance needs emphasis.

These operations, however, convinced at least one deeply interested spectator, Lord Brassey, to the extent of calling attention "to the urgent necessity for the construction of a class of torpedo vessels capable of keeping the sea in company with an armoured fleet." There is no one in Great Britain who takes a greater interest in the progress of the British Navy than Lord Brassey, and we take pleasure in quoting from his letter of August 23 last to the *Times*, in which he expressed the following opinion: "The torpedo boats ordered last year from Messrs. Thornycroft and Yarrow are excellent in their class. But their dimensions are not sufficient for sea-going vessels. We must accept a tonnage of not less than 300 tons in order to secure thorough seaworthiness and sufficient coal endurance. A beginning has been made in the construction of vessels of the type required. To multiply them with no stinting hand is the paramount question of the day in the department of construction. The boats attached to the Channel fleet at Milford Haven will be most valuable for harbour defence, and for that purpose they are greatly needed. Torpedo boat catchers are not less essential to the efficiency of a fleet. The gunboats attached to the Channel fleet were built for service in the rivers of China. They should be reserved for the work for which they were designed. We require for the fleet more fast gunboats of the Curlew and Landrail type. I trust that the next estimates for the Navy will contain an ample provision for building gun vessels of high speed."

As torpedoes must be carried, the next point to which we would call the attention of our readers is the very rapid progress that has been made in the boats designed to carry automatic torpedoes. A very few years ago the names of Thornycroft and Yarrow were almost alone as builders of a special type of vessel to carry them. To-day, in addition, we have Schichau, White, Herreshoff, Creusôt, Thomson, and others, forming a competitive body of high-speed torpedo boatbuilders who are daily making new and rapid development—almost too rapid, in fact, for the military student to follow. As new types are designed, additional speed gained, or increased seaworthiness attained, public descriptions of quickly follow, and we have ourselves recorded the various advances made so fully that it will be unnecessary to enter into details here.

As late as October, 1885, an able writer said: "The two most celebrated builders of torpedo-boats in the world are Thornycroft and Yarrow, in England. Each is capable of producing a first-class torpedo-boat, from 100 ft. to 130 ft. long, and with 10 ft. to 14 ft. beam, that will steam at the rate of from 18 knots to 22 knots per hour for 370 knots, or at the rate of 10 knots per hour for 3000 miles. A second-class torpedo-boat is from 40 ft. to 60 ft. long, and with 6 ft. or 8 ft. beam. The use of these boats is gradually being abandoned in Europe except for use from sea-going ships; but in Europe the harbours are very small, and it has been found that practically every torpedo-boat for coast defence must be able to go to sea. The tendency is, therefore, to confinement to the first-class boats."

In a paper on "Naval Torpedo Warfare" prepared in January, 1886, for a special committee of the American Senate, by Lieutenant Jaques, of the American Navy, we find the following reference to the progress in torpedo-boat construction: "The development in torpedo boats has been phenomenal, the last year alone showing an advance from a length of 120 ft., and a speed of 19 knots, which were considered remarkable qualities in a first-class boat, to a length of 140 ft., and a speed of 23 knots loaded (carrying 15 tons), and 25 knots, light, together with the introduction of novel features of importance. Although Messrs. Yarrow and Thornycroft have brought the second-class boats to a very high standard in Europe, I believe they will soon be abandoned there even for sea-going ships (very few are now laid down), and that the great development will be in overcoming the disadvantages of delicacy and weakness by increasing their size, giving them greater manœuvring power and safety by the introduction of two engines and twin screws, and steel plate and coal protection against rapid-firing ammunition. Yarrow and Co. have already laid down some boats of this character that give promise of developing a speed of from 23 to 25knots."

In the Russian boat recently built at Glasgow, progress in this direction is also seen in the 148 ft. length, 17 ft. beam, the manœuvring powers and safety element of the twin screws. But while the boat is fitted for the 19 ft. torpedo, a weapon of increased range and heavier explosive charge, it suffers from the impossibility of broadside fire and the disadvantages that Gallwey has named, "The great length of this torpedo, however, makes it a very unhandy weapon for a boat, besides which its extra weight limits the number which can be carried."

While, perhaps, Messrs. Thomson have been the first to show the performance of a twin-screw torpedo boat in England, the one completed in June last by Yarrow for the Japanese Government recalls the intelligence that Japan has exercised in the selection of types. Commencing as far back as nine years ago, the Japanese were probably the first to introduce sea-going boats, and they have been the first power to initiate the armour type, one of which was shipped last summer to be put together in Japan. As before stated, it was built by Messrs. Yarrow and Co., was 166 ft. long, 19 ft. beam, with twin screws, 1 in. steel armour, double engines, with bow and broadside torpedo guns, the latter so arranged as to greatly increase their efficiency.

While the advances are not restricted to the

English builders, a glance at the points to which Thornycroft and Yarrow have brought their improvements up to the present time, will indicate that their achievements are not only equal to but greater than those of any other builders. The former has boats under construction 148 ft. long, 15 ft. beam, to make 420 revolutions with 130 lb. of steam, the guaranteed speed being 23 knots on a continuous run of two hours' duration, with a load of 15 tons. They will have triple-expansion or compound direct-acting surface-condensing engines and twin screws, Thornycroft's patent tubulous boilers, double rudders, electric search lights, three masts and sails. While the armaments of the various boats differ, Thornycroft is prepared to fit the launching tubes with either air or powder impulse, to mount the tubes forward or on deck, and also the fittings for machine and rapid-firing guns.

Yarrow and Co. have contracted for boats varying in length from 117 ft. to 166 ft., with fittings and armament as may be required. They have obtained excellent results in their last English boat of the Admiralty type. They are, in fact, prepared to guarantee a speed of 23 knots in a length of 125 ft. and 25 knots in a length of 140 ft,, carrying in both cases a mean load corresponding to fuel and armament of 10 tons.

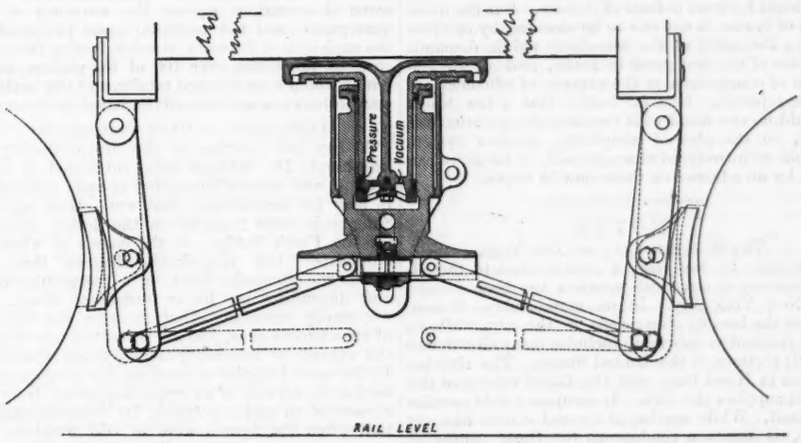
And so the progress goes on, but it will not stop here; it has already incited a marked development in ship construction, and the endeavours to withstand torpedo attack, have improved the defence against gunfire also.

In quoting a German opinion on the development of the Russian torpedo fleet, Charmes refers to the type which will, no doubt, be most successful upon the sea, namely, the torpedo cruisers, and it is to this type, more than for any other, that we may expect torpedo boats to be adapted. Already writers have dropped the phrase "torpedo boats" for "torpedo vessels."

THE INTERCHANGEABLE AUTOMATIC BRAKE.

EVERY traveller must be aware of the confusion and difficulty introduced into railway traffic in England by the adoption of three different types of continuous brake. Trunk line trains, which run over the ground of several companies, are often fitted with two complete sets of brake apparatus, while the engines are similarly equipped with both pressure and vacuum appliances. As carriages are detached from the original train, and are despatched by branch lines, the one or other set of apparatus can be coupled up according to the system prevailing on that line. This duplication of brake mechanism is expensive and complicated, but as long as each company persists in regulating its affairs without regard for its neighbours, there seems to be no other method of working through traffic. Compromises have often been suggested, and notably by Westinghouse, who designed a modification of his apparatus, which could be operated either by compressed air or vacuum, but it has never been adopted. Quite recently another method of equipping rolling stock, so that it may be able to run indifferently on lines pledged either to the Westinghouse or the automatic vacuum systems, has been brought out, and on Wednesday last a number of trials of it were made before a company of railway and Board of Trade officials, on a branch line near Ipswich. The new brake, which is in the hands of a syndicate represented by Mr. John Hardcastle, of Victoria-square, Leeds, is the joint invention of the late Mr. J. Cowling Welch and of Mr. Parker-Smith; it is illustrated, in so far as regards its principle, in the annexed engraving. Each vehicle is fitted with two train pipes of the usual character and dimensions, the one corresponding to the standard Westinghouse pattern, and the other to the automatic vacuum pattern. When one pipe is coupled to the adjacent vehicle the other is left free, the two being entirely independent in their operations. There are, as will be seen from the engraving, two concentric cylinders, between which there works a hollow ram. The air pipe has communication with the space between the ram and inner cylinder, and when air is forced into the pipe the ram is raised; the vacuum pipe is connected to the interior of the ram and when it is exhausted the ram also rises. Thus the presence of pressure or vacuum in the respective train pipes raises the ram, and takes off the brake in the usual way. When the train pipe is placed in communication with the atmosphere, either through the driver's valve, or by the rupture of the train, the ram falls, and by its weight puts on the brakes. Here is a point of difference—although not a novel one—between the system under notice and those in general use, the action of a weight replacing the compressed air from the reservoir in the Westinghouse apparatus, and the effect of the upper part of the cylinder in the vacuum apparatus.

The weight of the ram is 445 lb., and acts through a toggle joint upon blocks at each side of all the wheels, and not, as the engraving appears to suggest, on one side only. The toggle bars are jointed to rods screwed into a sleeve which is free to move endwise in a bearing at the bottom of the ram, so that if one set of brake blocks should wear more rapidly than the other, the toggle rods will move to accommodate themselves to the altered circumstances. At the bottom of the stroke the rods of the joint make a very obtuse angle with each other, and a moderate amount of wear of the brake shoes would remove the pressure entirely were there not an automatic appliance which constantly lengthens the rods as they require it. To this end the sleeve, into which the bars are screwed, is capable of being rotated by means of a ratchet and pawl, and when it is turned



the rods screwed into it are forced outwards, and are thus virtually lengthened. The pawl is linked to the framing, and when the ram descends beyond a certain point, the pawl catches in a tooth of the ratchet wheel on the sleeve, and partly rotates it.

In addition to the two forms of brake already described, each vehicle is fitted with a hand brake for use in shunting, and when motive power is not available for raising the ram. A handle operates a crankshaft, which is connected by levers and links to the ram in the cylinders. When the ram is raised nearly to the top of its lift the crank passes the centre and comes against a stop, and in this position the brake is held securely off, until the motion of the hand lever is reversed, or until the vehicles are coupled up to an air pump or ejector on an engine. The moment pressure or vacuum is established in the cylinders the pistons rise to the top of the stroke, and in traversing the last inch they operate a trip device, which releases the hand mechanism and returns all the hand levers to the positions they occupy when the brake is "on."

On Wednesday last a series of experiments were made with a train of six trucks fitted with this brake; the weight of the trucks was 54 tons 6 cwt. exclusive of the engine, which weighed 38 tons 11 cwt., and had four coupled driving wheels fitted with the Westinghouse brake. The plan of operations was to allow the train to run from a quarter to half a mile until it attained a speed of 25 to 40 miles an hour, which was accurately measured, and then to slip the engine and thus apply the brakes, measuring the distance required to effect the stoppage. The measurement of the speed was carried out on the last 146 ft. of the run, by means of electric apparatus which registered the time the engine entered and left the measured section, and measured its duration in quarter seconds; by aid of a table the speed in miles per hour could be read off for the interval occupied in passing through the section. The spot at which the slip took place was marked by a man throwing down a flag, and could also be noted by the spectators, who were apprised of the opening of the train pipe by the rush of air which took place. The ground had been previously measured and the distances chalked on the rails. The times were taken by a watch, and are only approximately accurate.

The first series of runs was made (see Table) with the Westinghouse pipes coupled, and comprised

Experiments with the Interchangeable Continuous Automatic Brake.

No.	Distance Run.	Time occupied in Stop.	Speed of Train.	Equivalent Height.	Coefficent of Retardation.
		COMPRESSED AIR.			
	ft.	seconds	miles	ft.	
1	179	9	26	22.5	.125
2	188	8	28	27.5	.145
3	250	11	30	30.2	.12
4	322	11	33	36.	.113
5	322	11	33½	37.4	.116
		VACUUM.			
6	459	..	40		
7	441	15	40	56.2	.126

five trials at speeds varying from 26 to 33½ miles per hour. A second series was then made without uncoupling the engine, but the distances run were considerably greater, and as this series has no value in relation to the new brake, it is not included in the Table. The third series was similar to the first, except that the vacuum part of the apparatus was used, the train pipe being exhausted by aid of a small boiler carried in the last truck. The programme was run through without a hitch, and, as far as it went, was quite successful. It must, however, be conceded that it did not go very far, for the peculiar difficulties found in continuous brakes do not manifest themselves with short trains. With a train pipe extending only the length of six trucks comparatively little time is lost in getting on the brakes, and the blocks at the rear end close on to the wheels very soon after those at the forward end. But even with a short train and under favourable circumstances, the action takes a measurable time to travel, for when the hand brake levers were set over and were tripped by the air pressure raising the rams the last inch, the levers fell in succession, and not simultaneously. If the train had comprised fifteen passenger coaches the slowness of the action would have been much more marked, and it would have been seen that although the brake can employ compressed air, it cannot compare with the Westinghouse for quickness in applying the blocks. Even as it is, the time occupied in stopping at a speed of 30 miles an hour—11 seconds—is not as little as it would have been if the contents only of the train pipe had to have been evacuated, and not also the contents of all the air cylinders. As compared with the automatic vacuum brake the new appliance should be equally quick, if not quicker as the volume of the cylinder appears to be less. All the air can be admitted at the end of the pipe, or subsidiary valves may be placed, as is often done, at different parts to aid the inlet, and to prevent the rear vehicles pressing upon those in front, which otherwise would be checked while those behind them were running free.

If we turn to the mechanical details they are distinctly inferior to both classes of brake which it

is sought to replace. The toggle joint with long links has often been tried for brake purposes, and almost as often abandoned. At flat angles it becomes practically a solid bar between the two blocks, and will not give back in the slightest degree however much the end pressure on it may be increased; very often the reduction of the vertical load on it will not diminish the grip on the blocks, and an actual upward pull must be exerted before the apex of the toggle will rise. The first action is very detrimental to the rolling stock, while the latter interferes with a regulated brake action, and requires that when once the blocks are on they must be lifted off before they can be applied more lightly. When the brake is worked by compressed air also, the nature of the arrangement is such that there are two sliding joints at which leakage can occur instead of one, as in the Westinghouse, while, moreover, these joints are constantly exposed to the air pressure, instead of being subjected to it only at the moment when the brakes are applied. In a train which had been some time in service we should expect this air leakage would become excessive and involve much trouble.

It seems somewhat exacting to demand that an apparatus which only professes to be a compromise should possess all the good features of both systems which it endeavours to comply with, and also that it should have no defects of its own. But the question of brakes is not one to be decided by compromise; the safety of the travelling public demands the use of the best possible brake, and all suggestions of compromise at the expense of efficiency are to be rejected. It is far better that a few trains should be run fitted with two sets of apparatus than that, on the plea of simplicity, another system should be introduced characterised, so far as we can see, by no advance on those now in vogue.

NOTES.

The Electric Club of New York.

During the last year, a club devoted to the advancement of electrical interests has been formed in New York City. In its membership, it comprises the leading electricians in the city, while its non-resident membership includes many electricians in all portions of the United States. The club has rooms in Hotel Dam, and the famed cuisine of this hotel supplies the club. It occupies a field peculiar to itself. While serving as a social centre like any club, it forms a rendezvous for those connected with electric interests either in a scientific or commercial manner, and at the dinners of the club, which are held every month, in place of the conventional post-prandial exercises, a paper is read on some electrical theme, and subjected to a general discussion, which never lags for want of speakers. In this manner this club, by the frequency of its meetings, presents a field for the consideration of side issues in electrical work, which is not afforded by the meetings of technical or scientific societies held at longer intervals, while as a club it affords an opportunity for acquaintance and informal meeting of persons of congenial tastes.

New Small Calibre Repeater Rifle in Denmark.

The Danish War Department has for some considerable time being directing its attention to a small calibre rifle, and a series of experiments have taken place with this object in view. The result is giving great satisfaction. The department have not only succeeded in producing a thoroughly satisfactory repeater model, but the difficulties from the small calibre have been satisfactorily overcome, and an 8-millimetre cartridge has been adopted. By coating the leaden ball with copper, and by pressing the powder in the cartridge, a velocity of 150 ft. above that mentioned by the Austrian Minister of War has been obtained. There is no depositing of lead in the barrel, and the wear and tear from a bullet coated with copper is of course very small. The accuracy of the shooting continues unaltered without cleaning the barrel—even when as many as 50 to 100 shots have been fired. The accuracy of the fire is proved by the fact of more than half of the shots at a distance of 1200 ft. being covered by a belt about 6 in. broad, and the distance between the highest and the lowest hit being only about 8 in. as far as half the shots were concerned. At a distance of 3200 ft. these figures were only increased to $2\frac{3}{4}$ ft. and $2\frac{5}{8}$ ft. respectively.

Carbonic Oxide in a Railway Tunnel.

A serious mishap, which narrowly escaped being a deplorable catastrophe, occurred in an American railway tunnel. The grade of the railway through the tunnel is quite steep, and at the time the incident took place, about forty men were employed lining the tunnel with béton. A heavy freight train in ascending the grade became stalled in the tunnel, and the driver set the brakes and used the steam blower until a maximum pressure of steam was obtained, when the locomotive was able to draw the train out of the tunnel. After the train had left the tunnel, a divisional superintendent entered in an opposite direction, riding on a hand car operated by two men. They saw two men lying on the floor of the tunnel, and supposing that they had been killed by the train, stopped the car and placed the bodies upon it; soon they saw others lying senseless, and divining the cause from the stifling gases in the tunnel, they pressed ahead and reached the mouth of the tunnel in a very weak condition. Help was summoned, and all of the men were rescued and resuscitated by prompt treatment. The large amount of gas produced by the forced fires of the locomotive standing in the tunnel had been almost noxious enough to prove fatal to every one in the tunnel. A similar instance occurred at the Craral quarries on the 20th of September, when a large number of excursionists who had assembled to witness the great blast, ran to the scene of operations against the warnings of the quarrymen, and the mephitic gases produced by the explosion of 7 tons of powder issuing from the crevices, prostrated over 100 of the visitors, about ten of whom were affected fatally, and the health of many others was undoubtedly impaired by the shock.

Instability in Open Structures.

At the last meeting of the Royal Society of Edinburgh, Dr. Edward Sang submitted a paper dealing with cases of instability in open structures. It may be remembered that some time ago Dr. Sang made some remarks on the design proposed for the Forth Bridge, in the course of which he enunciated the remarkable theorem that any symmetric structure built on a rectangular base, and depending on linear resistance alone, was necessarily unstable. That theorem was only one of an extensive class, and he, therefore, now took up the subject of instability among linear structures. In the case of regular or semi-regular arrangements having the corners of an upper supported from the corners of an under polygon, Dr. Sang maintained that when the figures were of odd numbers the structures were stable, while those with even numbers were unstable, unless the polygons were placed conformably, in which case the stability extended to both classes. Having given some mathematical examples of his contention, the author remarked that these cases of instability in open structures had been elicited by means of the simplest considerations in geometry and statics; they lay, indeed, on the very surface of mechanical inquiry. They did not occur as isolated examples, but were arranged in extensive groups, and being found in those classes of structures which might be called shapely, they stood out as warning beacons to those who were engaged in engineering pursuits. Dr. Sang's theories, however, cannot be accepted without more consideration than can now be given to them. Sir William Thomson, who was present, pointed out the effect of heat on redundant struts, and gave it as his opinion that in large iron structures it was of great importance to avoid them, one reason for doing so being that the difference of temperature in different parts of the structure might by expansion render it unstable.

England and Petroleum Tank Cars at Batoum.

The Tiflis newspaper *Kavkaz* announces the arrival at Batoum of 500 new oil tank cars, intended for the Transcaucasian Railway. As each tank car holds 10 tons of oil, this number will increase at a stroke the carrying capacity of the railway by 5000 tons. It would be interesting to know what effect this news will have on those persons who declared a few months ago that the Baku-Batoum Railway was carrying as much oil as it possibly could, until the Suram Tunnel was made, and that a limit had been fixed to Russian competition with America from that quarter. That was a view contested by Mr. Charles Marvin, in his "Coming Deluge of Russian Petroleum," and as the figures he gave of the attainable capacity of the line were derived from official sources, we readily sustained his opinion in these columns. Another point he laid stress on, that the Novorossisk oil outlet would be opened up this year by the railway, thereby bringing the Black Sea petroleum fields into competition with America, was at total variance with the report presented by Colonel Stewart to the London Chamber of Commerce, about the same time in which that officer predicted that the line would not be opened "for two or three years" owing to a difficult tunnel. Colonel Stewart, however, is unfortunately ignorant of Russian, and must have been the victim of some misconception during his visit, for while his report was yet in type the tunnel was half finished; and since then the works have so far advanced that it will be completed in March. By the spring, therefore, the Novorossisk Railway will be quite finished from the Rostoff-Vladikavkaz line to the Black Sea, and the West Caucausus oilfields will lie open to European enterprise. It is from this district that petroleum is already being regularly shipped to Odessa in bulk to compete with English coal as liquid fuel, and to Marseilles, to be refined in the French refineries. The addition of the 500 tank cars to the Transcaucasian railways, we should remark, is not a final instalment, but the advanced guard of further supplies, which will reach Batoum and Baku during the spring in accordance with a new arrangement, whereby the refiners are now allowed by the Government to have their own rolling stock. Hitherto the company enjoyed a monopoly, and it was its refusal to increase the number of tank cars that has really caused the embarrassment to the traffic. The tank cars are either Russian or German—could not England secure an order for some of them?

The London, Chatham, and Dover Railway.

The London, Chatham, and Dover Railway Company's capital expenditure for the past year amounted to 285,057*l.*, consisting of 17,740*l.* upon sundry improvements and additions on open lines, including land for additional accommodation at Holborn Viaduct. On works in course of construction, or recently completed, the year's outlay comprised 90,374*l.* on the new City and Suburban traffic station at St. Paul's; 54,370*l.* on the Maidstone and Ashford branch; 11,000*l.* on the Gravesend line, and 8773*l.* on the widening of the suburban lines between Herne Hill and Bickley. The additions to the working stock comprised twenty first-class and fourteen third-class carriages, a large part of the cost of which must have been charged to revenue, as the total charge to capital under this head was only 15,546*l.* On the extension of the Queenborough Pier they spent 6357*l.* In order to keep pace with the growing demand of the public for improved accommodation, and to meet the competition by other routes, always becoming more severe, they have still further added to their steam fleet, which had previously been strengthened by the Calais-Douvres and the Invicta. The Victoria, the latest addition, for which, according to the accounts of the last half-year, a sum of 70,066*l.* was paid, has been run in the Channel service, between Dover and Calais, during a considerable part of the last half-year, and has achieved results, in respect to speed and comfort, not hitherto attained. In accordance with the contract, she ran forty trips as a test of her efficiency before being taken over, and besides proving to be an admirable vessel in all respects in running these trips, she accomplished a mean speed of nearly 19 knots, or upwards of $21\frac{1}{2}$ statute miles per hour, thus proving herself to be the fastest steamer in the Channel. The estimate of future expenditure on capital account amounts to a total of 654,000*l.*, of which one-half the estimated cost of the Maidstone and Faversham line is described as "works not yet commenced and in abeyence." The principal items are the Greenwich extension from Blackheath, 82,000*l.*; the widening of the suburban lines between Herne Hill and Bickley, 80,000*l.*; sundry extensions of stations, additional sidings, and other accommodation, 70,000*l.*; and the completion of the Queenborough Pier, 20,000*l.*; 10,000*l.* are also required for further rolling stock. An equal sum to that paid for the latest addition to the fleet of steamers—the Victoria—viz., 70,000*l.*, also figures in the estimates, as for a "new steamboat" from which it may be assumed it is contemplated to build a sister ship to that vessel.

Heating Passenger Cars in the United States.

The recent railway accident records of the United States have shown the occurrence of a number of accidents wrecking passenger trains, in which the stoves used in heating have added to the casualties death by burning, before help was available, persons bound by portions of the car. There are three systems of heating cars in use in

America. The long passenger cars have stoves at each end, with the doors locked "to keep the fire from going out." Sometimes the stove is in the middle of the car, or even underneath. Second—and the most generally approved method—is by a single stove used to heat some non-freezing liquid, as a solution of glyceride of calcium, or chloride of magnesium, which circulates through a series of pipes under the seats. These solutions are used, because there is no difficulty from freezing when the car is not in service, and, secondly, they can be heated under atmospheric pressure to a temperature of over 212 deg. Fahr. Third, there are numerous methods of using the steam from the locomotive, but there are also several matters which stand in the way of the general adoption of such an arrangement, as all the steam which can be generated in the boiler of a locomotive on an express train has a mission to perform other than warming cars; and these cars disconnected from the locomotive, waiting at terminal stations of junctions, would be without means of artificial heat. The subject has attracted the usual swarm of patentees, but little of a practical nature has been produced outside of the systems referred to. One professor of mathematics in a prominent technical institution has patented a method of heating cars by hot water warmed by means of revolving discs of cast iron in a box of water connected with the circulating pipes. The discs are to be revolved by means of some connection with the axle beneath the car. The principal use of this patent was to bring technical education into discredit. Railroad officials have authorised statements in the newspapers, stating the need of safer heaters, the railroad societies have discussed the matter, and the press devoted to railway interests have given prominent place to contributions and articles bearing on this subject which is so prominently brought to the front by the recent accidents. Steam from the locomotive is used to heat the cars on the elevated railroads of New York City, and some other places where a uniformity of conditions renders practicable such a use of a portion of the steam generated in the boiler. In all these instances we have low speeds, cars in constant use, absence of heavy grades, and quite constant patronage to an extent which cannot exist on ordinary surface railroads.

The South-Eastern Railway.

The South-Eastern Railway Company's capital expenditure during the past year amounted to the comparatively small sum 143,914*l.*, being 56,086*l.* less than the estimated outlay. The most important works they have in hand at present are the widenings of the Charing Cross and Cannon-street Bridges, and the new bridge across the Medway at Rochester. The company have taken advantage of the present exceptionally low prices of materials. The works are expected to be completed shortly, and they have found that the widening can now be made at about one-third of the original cost of the bridges. Over 100,000*l.* has been spent on these works during the past two years. On the Medway Bridge and Chatham extension about 50,000*l.*, out of a Parliamentary estimate of 215,000*l.*, has been up to the present expended. It is expected that the widened lines and bridges will lead to a considerable saving of working expenses, and to more efficiency in providing for a crowded and increased traffic. About 18,000*l.* was expended in the year upon the completion of the Croydon and Oxted joint line. The additions to the St. Leonards Station have cost over 5000*l.*, and a large outlay has been going on in connection with the Hastings Station enlargement and improvements. The outlay in dredging and works at Boulogne Harbour, amounting to 17,000*l.*, has enabled the company to substitute a fixed for a tidal service. The fixed service has now for some time been working with satisfaction to the public, and further improvements, it is stated, are in comtemplation to expedite the interchange of both passengers and goods. A feature in the year's outlay are the law and Parliamentary charges, amounting to over 14,000*l.*, in addition to a nearly equal sum charged against revenue. The rolling stock additions charged to capital comprise two goods engines, 3065*l.*; one first-class and two lavatory carriages, six horse boxes, and six luggage vans, at a cost of 5538*l.*; and vacuum brakes, 3614*l.*; the total being 12,217*l.*; 7500*l.* was written off for depreciation of steamboats, and charged to revenue. The fleet of steam packets now stand at a book value of 257,000*l.* The estimate of further expenditure shows a total of nearly three millions; but it is explained that that is the amount of capital which Parliament has authorised the shareholders to expend, if they see fit and so order. It is stated that not more than a tenth part of the sum will be spent in the next three or four years. The Blackfriars and Bricklayer's Arms line and widenings figure for no less a sum than 1,069,400*l.*; the extension of Folkestone Harbour, 398,000*l.*; the Charing Cross line, for land and compensation, 296,000*l.*; a new loop line from Northfleet to Snodland, 272,000*l.*; widenings on the North Kent and Dartford lines, 192,000*l.*; Hundred of Hoo line, which has now been open for some years, 166,000*l.*; and the Cranbrook and Paddock Wood line, 127,000*l.* It is doubtful, however, if any other works than those now in hand will be undertaken for several years to come. A screw steamer for the merchandise service has been ordered from Samuda Brothers, and a "Jubilee" steamship will also be added to the fleet. This craft, while available for merchandise service and towing, will be more especially designed for saving life at sea.

Western Union Telegraph Company.

The accounts of this company for the financial year ending June 30, 1886, exhibit discouraging results, the profits of the company having been very seriously reduced for the twelve months by the frantic competition which appears to be peculiar to the United States. The receipts of the undertaking in 1885-6 were 16,298,638 dols., as compared with 17,706,833 dols. in 1884-5; 19,632,939 dols. in 1883-4; 19,454,902 dols. in 1882-3; 17,114,165 dols. in 1881-2; 14,393,543 dols. in 1880-1; 12,782,894 dols. in 1879-80; 10,960,640 dols. in 1878-9; 9,861,355 dols. in 1877-8; and 9,812,352 dols. in 1876-7. While the gross receipts were 6,486,286 dols. larger in 1885-6 than in 1876-7, the net profit only expanded in the ten years to the extent of 779,728 dols. The net profit for the ten years ending June 30, 1886, inclusive, was as follows, year by year; 1876-7, 3,140,127 dols.; 1877-8, 3,551,542 dols.; 1878-9, 4,800,440 dols.; 1879-80, 5,833,937 dols.: 1880-1, 5,908,279 dols.; 1881-2, 7,118,070 dols.; 1882-3, 7,660,350 dols.; 1883-4, 6,610,435 dols.; 1884-5, 5,700,924 dols.; and 1885-6, 39,198,855 dols. The efforts of the Western Union Telegraph Company to acquire a monopoly of the telegraphic business of the United States have thus practically resulted in failure, the profits having experienced a contraction of nearly 50 per cent. in the last three years. Notwithstanding these temporarily discouraging results, the whole history of the Western Union Telegraph Company has been one of acquisition and absorption. To go back no further than 1878, we find that in that year a consolidation took place with the Atlantic and Pacific Telegraph Company. The Western then fondly thought that it had got the whole telegraphic business of the United States in its own hands. In 1879, however, the American Union opposition line was started under the formidable auspices of Mr. Jay Gould. In January, 1881, what is sometimes termed the "grand consolidation" took place, by which the Western Union Company raised its capital stock to 80,000,000 dols., giving par, or 15,000,000 dols. for the stock and bonds of the American Union Company. Another attempt at opposition was made in 1883 by a concern named the Mutual Union Telegraph Company, but in February, 1883, a lease was agreed upon. Once more the Western Union Company thought that the vast territory of the United States was at its exclusive disposal as a field for its operations; but it has now to deal with a fresh rival in the shape of the Baltimore and Ohio Telegraph Company, while its European ally, the Anglo-American Telegraph Company, Limited, is seriously hampered with the competition of the Mackay-Bennett cable. By this time, we should imagine, the directors of the Western Union Telegraph Company must have become pretty well convinced that the idea that they can obtain and retain a monopoly of American telegraphic business is a mere chimera. At the same time, it is perhaps due to the Western Union Company to say that, as a result of its acquisitions, its amalgamations, and its extensions, it has built up a splendid system of lines, the extent of its poles and cables having grown from 46,270 miles in 1866-7, to 151,832 miles in 1885-6. Similarly, the length of wire which it has at work has expanded from 85,291 miles in 1866-7 to 489,607 miles in 1885-6, while the number of offices has been carried from 2565 in 1866-7 to 15,142 in 1885-6. During the ten years ending June 30, 1886, the number of telegrams forwarded by the company has shown an unchecked increase from year to year, having been 21,158,941 in 1876-7; 23,918,894 in 1877-8; 25,070,106 in 1878-9; 29,215,509 in 1879-80; 32,500,000 in 1880-1; 38,842,247 in 1881-2; 41,181,177 in 1882-3; 42,076,226 in 1883-4; 42,096,583 in 1884-5; and 43,289,807 in 1885-6. It will be seen that the number of messages transmitted annually has nearly doubled during the last ten years, while if we carry the comparison back to 1866-7 we find that since then the yearly total has multiplied nearly eightfold.

Mining Notes from Norway.

Two Norwegian gentlemen, who in the autumn made a tour of inspection to the Bömmelö and neighbouring mining districts, have sent in a report to their Government, of which an extract may be of interest. The Bömmelö has attained a certain—not altogether flattering—notoriety during the last few years on account of its gold mines, and although the gold fever of some few years back has subsided, there are still several distinct companies on the island, that go in for work, mostly, if not exclusively, of an experimental and preparatory nature. The original Oscar Mining Company, Limited, having run through its capital, a "New Oscar Mining Company, Limited," has been formed; this is the most important concern on the island, and possesses several regular mines, the Oscar, the Daws, and the Gorks being the most prominent. The Oscar mine was the only one fully accessible at the time of the visit, but the new company had not yet started rock breaking. The depth of this mine appeared to be some sixty odd metres, but is very irregular. The ore is mostly found in layers of quartz and a few other minerals. The quantity of gold in the ore is probably very uneven and varying, sometimes satisfactory and sometimes very insignificant. At Daw's mine they were engaged in pumping water and propping, and the ore is here said to be less straggling. The quality, too, was good, and great expectations are entertained about this mine. The depth was about the same as at the Oscar mine. The Gorks mine was full of water. The company has a lot of expensive machinery for the various branches of work, and steam power is used. The system employed for obtaining the gold is the amalgamation method, although this process by many is thought to be better adapted for alluvial gold. A Norwegian company, Bömmeloens forenede Grube-Kompagnier (the United Mining Companies of the Bömmelo) have also done no small amount of work. This company have secured a good deal of property, where preliminary work has been going on. They are at present experimenting in three places, at Karl Olsen's mine, at Flatanäs, and at Hilde; the former is the most important, and has got down to a depth of 50 metres; it is worked by a steam engine. They have here recently come upon a vein of quartz about 1 metre broad, and said to contain gold. At Flatanäs they have got some 20 metres down, and some little gold had recently been obtained; Hilde appears to be somewhat more promising, with more regular finds of visible gold. The company is at present building a laboratory for gold analyses, which will possibly afford useful and valuable guidance. When this is done, it will be possible to arrive at definite conclusions as to where working will pay and where it will not. Besides these two companies, which really do carry on regular mining industry, there are a number of small companies and private persons, who own more or less important properties, purchased "on spec," with the evident view of selling them to some large foreign company, or otherwise disposing of them. The work done by these small concerns does not amount to much, nor are their analyses numerous or reliable enough to enable one to form a correct idea as to the value and prospects of their property. We are under the impression that gold exists in a great many—perhaps a thousand—places, but regular mining would probably prove that only few veins would be worth the working. Those at present enjoying the best reputation are Oscar, Daws, Hangesund, Karl Olsen's, Hilde, and two newly-discovered ones, Syvert Johansen's and Engel Nilsen's, besides "the green tree," where some experimental work has been done by a Swedish company. At Olve gold was found rather more than a year ago, and it seems here to accompany iron ore, which, however, does not appear to exist in any great quantity. This place is at pre-

sent being worked by an English syndicate with the intention of forming a limited company for the further utilising of the mines, and although the gold analyses on the whole are poor, yet it may turn out a profitable undertaking, as many of the circumstances connected with the property are undoubtedly favourable. Sulphur ore is found in several places close to Koiteberg, but the Dalemyr mine is the only one that is being worked; it is about 50 to 60 metres deep, the vein is about 1 metre broad, but the ore is of good quality. The yearly production, however, amounts only to some 500 tons of ore. On the Varaldsö, which belongs to an English company, sulphur ore is found in considerable quantities, the veins in some places have a breadth of several metres. At Kisleiestedet there are three pits, the one worked at present is situated some 1000 ft. above the level of the sea; steam power is used here to a considerable extent. The annual output is 5000 to 6000 tons, but owing to the low prices ruling for sulphur ore, the working of this mine is not unlikely to be discontinued.

ENGLISH *v.* AMERICAN LOCOMOTIVES.

To the Editor of Engineering.

Sir,—In looking over the numbers of your paper for 1886, I notice an extended discussion on the merits of English and American locomotives. Mr. R. H. Burnett, who I gather has had charge of both English and American engines, proves to his own satisfaction the superiority of the English engine. I have had no experience with English engines, but an extended one with American engines, as machinist, locomotive engineer, draughtsman, and division m.m., or general foreman, and from Mr. Burnett's remarks concerning the American engines—but for your assertion to the contrary—I should conclude he had never seen an American engine, much less have had charge of them.

In your issue of April 30th, Mr. Burnett makes a comparison of what he calls an American engine and an English engine. As a matter of fact the engine "169" he alludes to is a "Wooten engine," and not a representative of the American type at all, as the size of the grate clearly indicates. The Wooten engine was designed, I believe, for the purpose of burning anthracite coal dust, and is, in fact, a patented design. No American type of engine has any such grate area—38 square feet—as 95 per cent. of American engines will not exceed 18 square feet. The designer of the Wooten engine also had probably in view the value of firebox surface for steam generating, regardless of economy, because it has been found that the difficulty of hauling *heavy* passenger trains of 275 to 300 tons at high speed has been a want of steam. And if, as in this country, this necessity should be felt in England, it would be found that something similar to the Wooten boiler would be necessary. Speed and heavy loads are the first consideration in America; economy of fuel being secondary. I doubt if the claim of economy has ever been made for the Wooten engine, but if a test of heavy loads *with* high speed for long distances be ever made between a typical English engine and the "Wooten" the latter will "show up" several times superior. Not long since a test of a Wooten engine was made on the New York, New Haven, and Hartford road, with one of the company's engines, which was an ordinary typical American engine. The Wooten engine had 21 in. by 22 in. cylinders and 68 in. drivers, while the competing engine had 18 in. by 22 in. cylinders with 66 in. drivers. Following is the data of the test:

	Company's Engine.	Wooten Engine.
Engine mileage... ... miles	1,212	1,212
Car ,, ... ,,	8,123	7,455
Average number of cars per train	6.70	6.15
Gross consumption of coal, lb.	50,680	61,090
,, ,, water, galls.	50,400	59,250
Coal per engine mile... lb.	41.81	50.40
,, car ,, ,,	6.24	8.19
Water evaporated per pound of coal ... ... lb.	8.292	8.087
Average steam pressure ...	142	150
Water per engine mile lb.	346	418
,, car ,, ,,	51.7	68.1

Thus the Wooten engine used 32 per cent. more steam than its competitor, per car mile. The speed was within a small fraction of 40 miles per hour. The Wooten engine was simply too large for the service, and the comparison is therefore useless. But if the Wooten engine had a load of 12 cars in place of 6, and the test had been made with this load, the Wooten would have shown what she was built for, and there is no engine in England to-day that could take the load—12 coaches, or 350 tons—and hold a candle to her.

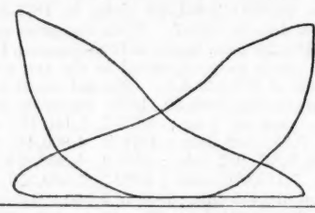
Mr. Burnett has therefore attempted to make a comparison between two dissimilar engines and not between a typical English and a typical American engine.

However, the facts are at hand to make such a comparison. Mr. Burnett has selected what is probably considered the leading type of English engine—the Gladstone. With this engine I desire to compare what is known in this country as the "Meehan" engine, designed by James Meehan, S.M.P. of the C.N.O. and T.P.R.R., and built by the Baldwin Locomotive Works, which is a representative design of the American type. These engines have more heating surface, and more weight per driver, probably than the average American engine, but are nevertheless of the pure American style. These engines have 18 in. by 24 in. cylinders, balanced slide valves, 240 2 in. flues, in a 58 in. shell, the top of which is 9 ft. 8 in. from the rail; 68 in. drivers with about 16,500 lb. per driver, and 17 square feet of grate surface. The fuel is Tennessee coal and is loaded on the engine tender, two buckets of "slack" and one of "lump," and I take it is an inferior coal to that used by the Gladstone type. They are superb steamers, as I have ridden behind one with 25 cars on a grade 16 miles long, throttle wide open and full stroke, the load keeping her down to 20 miles per hour. Under these conditions she required both injectors on (No. 9), with the firedoor from 2 in. to 3 in. from being closed, the gauge standing at 160 constantly.

While testing these engines in regular service with a train of 9 cars, the gross weight of which was 292½ tons, not including weight of passengers or baggage, one of these engines (No. 81) made a run of 30 miles in 30 minutes, and burned 50 lb. of coal per mile. At the instant the accompanying cards were taken the engine was making 280 revolutions per minute. The cards show an average effective pressure of 57½ lb. per square inch, which means 993.2 horse-power. In the 30 miles she burned (30×50) 1500 lb. of coal, or at the rate of 3000 lb. per hour. Taking Mr. Burnett's basis of comparison of "consumption of coal per indicated horse-power per hour," and we have

$$\frac{3000}{993.2} = 3 \text{ lb.}$$

Mr. Burnett gives the "Gladstone" engine's consumption as 2.05 lb. on the same basis. But she was travelling at but 43.3 miles per hour. What she would have burned at 56.6 miles per hour—the speed of the "Meehan" engine—I do not know, as under the circumstances it is quite probable she could not have reached that speed at all and maintained it; but assuming that the resistance increases as the square of the speed, and that the consumption of fuel would have been in this ratio, we have 3.48 lb. per horse-power per hour for the Gladstone engine, which is considerably in favour of the "Meehan" engine. And still this comparison is no more satisfactory than Mr.



Engine No. 81 *Cincinnati, New Orleans, and Texas Pacific Railroad.*

Cylinders	18 by 24
Gauge pressure	160 lb.
Mean effective..	57½ lb.
Revolutions	280 per min.
Drivers	68 in.
Scale of diagram (as engraved)	120 lb. = 1 in.
Speed of engine at time card was taken ..	56.6 miles per hour

Burnett's, because if the Gladstone engine could have reached that speed and maintained it with her load, she would have developed more horse-power, which would have probably shown a smaller consumption per indicated horse-power than that given. However, this correction for difference in speed is quite as fair as Mr. Burnett's, although such corrections are too problematical to be of any real value, because the performance of an engine at a given speed cannot be safely assumed from what she does at some lower speed. In fact there is nothing going to show that the Gladstone engine could have reached and maintained a speed at the rate of 56½ miles per hour, for 30 miles, while from the fact that the Meehan engine had done so for 30 minutes and had 160 lb. pressure by the gauge at the finish, was conclusive that she could have continued, but for a heavy grade and numerous tunnels in an unfinished condition necessitating a reduction of speed. However, from this performance of the Meehan engine, it is evident that her performance is equal at least to the Gladstone engine. The exhaust nozzles (two, one for each cylinder) of the Meehan engine were each 3⅝ in. in diameter. The cards from this engine show a back pressure up to commencement of compression of 6 lb., and considering the high (as compared with the Gladstone engine) initial and boiler pressure, this amount is less than that engine showed.

What would more lead a person acquainted with American engines to believe Mr. Burnett had never seen one is his remarks about the engine truck frame (bogie) being a rough piece of country blacksmith work? I have been acquainted with these trucks for seventeen years. They are surfaced on a planer for the jaws and braces, which are also surfaced and bolted with turned and driven bolts. What more is done on an English truck I cannot imagine—because no more is necessary. However, the completeness with which their trucks fill the purpose for which they are designed is the real measure of their value, and when such truck frames run for seventeen years within my own knowledge without a cent of repairs, unless injured by a collision, I cannot see that Mr. Burnett's objections amount to anything. I have seen hundreds of engines with these trucks come into the shop for an overhauling, and there it no instance in my memory in which anything was done to the truck frame save cleaning the grease off. Of course the *jaws*, after three years' service, are trued up and replaced, but it is not these I understand Mr. Burnett refers to, but to the frame. Mr. Burnett should find some detail that gives trouble if his objections are to stand, and not select the truck frame, which, like cast-iron eccentrics and straps, apparently run for ever. In fact, I can show Mr. Burnett fifty engines (on a road having 300) that were built thirty years ago with the original trucks still under them. Mr. Burnett, or some other contributor, speaks of American engines going all to pieces when they go into the ditch, &c. I have in mind a Baldwin engine that went off a bridge and fell 60 ft. into a grassy valley spanned by the bridge. That engine was running over the same bridge again in ten days, and with her original truck or bogie too. This was due to the splendid wrecking facilities possessed by the road, which allowed of picking the engine up quickly and in a greater measure to the absolute *interchangeability* of the Baldwin engines. The one in question had been in service ten years. The road was short of engines, and telegraphed the Baldwin Works to send a new cylinder and chest complete, new cab, side, and main rod, rocker arm, dome casing, pilot, &c., which came by express, and which all went into place without a particle of fitting. And herein lies in a great measure the superiority of the American engine. Twenty or fifty engines of the same order are all alike, absolutely interchangeable. A cylinder, rod, pair of drivers, eccentrics, or anything else may be taken from one engine and put in place without fitting on any other. The right-hand cylinder goes on either side; so do the rocker arms, rods, &c. I have seen in the Baldwin shops, as a test, the side rods taken down on three engines (ready to be delivered), the rods, straps, bolts, brasses, keys, &c., without any marks on them, disconnected and thrown promiscuously into a heap, and at once, without any selection, again erected, the rods probably being on another engine, while the balance were distributed among the three. This is interchangeability, of which, I understand, English builders know nothing. Think of the immense value of such a system to a road which, being supplied with the original templates by the builders, keeps in stock all details necessary for repairs. I have seen on the Chicago and Alton Railroad an engine come in with a cylinder, guides, yoke, main rod, side rod, running board, &c., knocked off or bent in a collision and the engine go out in twenty-four hours with these parts exchanged for new ones kept in stock. Can Mr. Burnett show anything similar in England, or where English engines are running? In a nutshell the American locomotive builders *manufacture engines*, the English locomotive builders *make an engine*. Mr. Burnett objects to steam chests on the top of outside cylinders, and thinks they ought to be in the smoke arch. On an American engine, owing to this very position of accessibility to which Mr. Burnett objects, the two steam chests can be raised, valves and seats faced, and all replaced in three hours. I am told by an English engine-driver, who is now running an engine here, that when he was "driving" an engine in England it required *three weeks* to face a bad set of seats on an English engine. The price of doing this with value of time of delayed engine would buy a new pair of cylinders and chests complete for an American engine; and is it to be wondered that American engines are prefered by stockholders who have got to pay for keeping up English engines?

I have never seen but one engine frame broken that was not the result of a collision, and this break was through a hole where the cylinder bolts on. It was discovered in taking the cylinder off to replace with a new cylinder, and had probably run in that condition two or three years without giving any trouble. I have been connected with roads using frames with the jaws or pedestals (or horn-blocks as you call them) both bolted and welded on, and have seen none broken, even in collisions. But suppose a frame does break in a collision, it always breaks, or rather bends, in front of the cylinders; it is but a day's work to unbolt the front section of the frame from the back and cylinders, straighten them up and replace them. But how about a break on an English plate frame? If I am not mistaken the engine would have to "come off her wheels," and the *whole* frame disconnected to patch a bad break.

The statement that English wrought-iron wheels are displacing American wheels in this country, is not true; I do not believe there are 150 pair of English spoke-wheels running in this country to-day. A road I was connected with put a set of English wheels under a sleeping car, but in a few months threw them out because the tyres cut badly on the flange, the spokes fanned the dust up from the road bed, causing the brasses to run warm, and two spokes in one wheel parted at the weld. Steel-tyred wheels with steel plate centres are largely used under passenger cars here, and are unquestionably superior to the English wheels—because the tyres are harder, they have no welds to open out, and are not built on the principle of a fan to aggravate the heating of brasses. What can be cheaper than buying a cast-iron chilled wheel, guaranteed to run 50,000 miles or no pay, for 8 dols., which, after making 50,000 miles, can be sold for scrap for nearly half of its original cost?

As to the comparative strength of cast-iron wheels and English spoke wheels, the following, related to me by Alfred Congdon, late general m.m. of the Lake Shore and Michigan Southern Railroad, who visited the prominent locomotive shops in England a few years back, is conclusive. He states that at a large locomotive shop in England he saw several new cast-iron chilled wheels lying, which had been sent for trial by an enterprising American wheel foundry. On asking the English locomotive superintendent why he had not fitted them up and tried them, he was informed, it was because the superintendent was afraid of them; "They are cast iron, you know," the superintendent said. Mr. Congdon said there were no two blacksmith strikers in the superintendent's shops who could break them, if the wheels were set up and struck on their tread. The superintendent laughed at the idea, but sent for two brawny "strikers" and their

heaviest sledges. They came, and, after pounding for several minutes, gave it up, without even cracking the wheel. Mr. Congdon then asked to see an English spoke wheel tried similarly, which was done, and resulted in opening a weld on a spoke close to the hub. If after so many years of condemning the American engine, and saying things accomplished here are impossible, because they are not accomplished in England, would it not pay English locomotive builders to spend a little time "looking into the matter," and not believe all that the "Mr. Burnetts" so confidently but erroneously state, and remember that after the English Arsenal authorities demonstrated (?) that it was impossible to turn in a lathe a gunstock, they adopted the American Blanchard lathe, and that an American steamboat crossed the Atlantic, notwitstanding Dr. Lardner had shown conclusively that it could not be done? Are not your mechanical papers lulling you with knowingly false statements? Not long since an editorial appeared in one setting forth that it was but lately that American locomotive builders had draughting rooms, but built engines from pine-sticks and memorandum books. There is not an American locomotive manufactory that, in my memory of seventeen years past, has not had the most complete of draughting rooms, and employing from six to twenty draughtsmen.

As to steel fireboxes, they do not last in the Northern States on an average sixteen years—that life is the exception and occurs only in small fireboxes. But in the Southern States, from some peculiarity of the water, the life of a steel or iron firebox is unlimited. In fact, on all the southern roads there are not probably five new fireboxes put in in a year, and many engines are still running with steel fireboxes 16 years old and iron fireboxes 25 years old. In the Northern States the life will average probably eight years, but I have seen many steel fireboxes in service eight years on roads where the water is so bad that the flues have to be removed and cleaned every six months. It has been found by the analysis of large numbers of fireboxes on a given road that the life of the firebox is longer as the amount of phosphorus is less in the steel, although the balance of the constituents are practically the same. Firebox steel is made in this country by a Pittsburg firm (Shoenbarger and Co.) with phosphorus as low as .011 of one per cent. by the open-hearth process, being purer than the ordinary crucible tool steel made here. English ingots of open hearth steel sent to this country and rolled here have not given good service as would be expected from the analysis as follows of two samples.

Carbon	.16 and .15
Phosphorus	.039 ,, .051
Silicon	.031 ,, .019
Manganese	.45 ,, .41
Sulphur	.010 ,, .022

The Shoenbarger steel shows as follows:

Carbon	.11 to .13
Phosphorus	.011 ,, .015
Manganese	.30 ,, .35
Silicon	.015 ,, .020
Sulphur	none

FRANK C. SMITH.

Delaware, Ohio, U.S.A., January 25, 1887.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "G," in last week's paper, is very hard on the "ignorance" of those on this side the Atlantic who have written on this subject, and seems to regard my not having known that "24" in. stood for 42 in. is an example of that ignorance. All I can say is, that in taking the width of the firegrate of the American locomotives, to which I referred in my previous letter as 24 in., I was simply adopting the figures as I found them in your paper, and to expect, as "G." seems to do, a man in my position, who, as I said before, does not pretend to be "scientific," to know that 24 stands for 42 is really expecting too much.

But taking "G.'s" explanation as correct, how does the matter stand? "G." says that in the American engines in question, the "firebox is placed above the frames." Here we have the admission that the use of the bar-frame, in the case of an engine with a grate only 42 in. wide, necessitates the box being lopped short and "placed above the frames," while in British locomotives, with *plate* frames, 42 in. is quite the common width of the grates of fireboxes of the full depth obtainable between frames. So that the correctness of the contention that the use of bar-frames materially narrows the firegrate, or necessitates the adoption of objectionable expedients—such as lopping short the firebox at the level of the tubes—which I think Mr. Fernie attempted to gainsay, is at length admitted by our American friends.

"G." says that "in actual practice, it is found that ample depth of firebox can be secured" even with the lopped box, "provided the barrel is properly raised up." But *are* the barrels of American locomotives "properly raised up" for the purpose, and sufficient heating surface obtained? If so, what explanation has "G." to make of the wastefulness in fuel of the American locomotives in comparison with those of the British make, as admitted in the quotations referred to by you in the following statement in your article on the subject in ENGINEERING of May 14th last, page 477, which none of the advocates of American locomotive practice have attempted to answer or explain away?

As to any superior economy on the part of American engines in the use of the steam when produced, or, in other words, as to any assertion that American engines perform more work per gallon of water evaporated than English engines, we need simply say that this is another popular delusion, the result we fancy of what is known at the antipodes by the short but expressive term "blow."

As showing that the contrary in regard to American locomotives is admitted even in the United States by competent authorities, we need merely quote the following extract from a paper read by Mr. F. W. Dean before the Master Mechanics' Association at Chicago in June, 1883, as given in the *Railroad Gazette* of June 29th of that year. He said: "The American locomotive is a "remarkably wasteful machine, both in the use of the fuel and the use of the steam after it is generated." Again, in a paper read more recently, in June, 1884, before the same Association at Long Branch, Mr. Angus Sinclair is reported in the *Railroad Gazette* of July 4, 1884, to have said: "The American locomotive compares unfavourably in the economical application of power with European locomotives of similar dimensions, doing similar work."

Perhaps "G." in the absence of Mr. Fernie, will favour us "ignorant" ones with an explanation.

Yours obediently,

Dorking, February 9, 1887. STOKER.

TESTING DYNAMOS.

TO THE EDITOR OF ENGINEERING.

SIR,—I see by Mr. Wilkinson's letter in your last issue, that my omitting to take into account the loss through friction (in my letter on page 35) makes the value of x there given to be only the conversional efficiency. But this need not prevent the method being employed in practice, for w (the loss in watts through friction) can be found *without using a brake* by running the machine as a motor, and noting the current c and electromotive force e required to run it at n revolutions when it is doing no useful work, then we get

$$w = e\,c\,x,$$

where x is the conversional efficiency given on page 35, equations (3) and c, and calling X the commercial efficiency when run as a dynamo we get

$$X = \frac{E\,c}{W + w}$$

$$X = \frac{E\,C}{(E_1 C + e c)\,x}$$

when run as a motor,

$$X = \frac{(E_1\,C - e\,c)\,x}{E_1\,C}$$

x being for a series machine $\sqrt{\frac{E}{E_1}}$, and for a shunt

$$\sqrt{\frac{E\,(C_a - C_m)}{E_1\,C_a + E\,C_m}}$$

The objection to Captain Cardew's method—as also to Dr. Hopkinson's—is that it requires two machines exactly similar in every respect, which may not be always available.

What Mr. Wilkinson—and I have followed him in doing so—calls the conversional efficiency is not, strictly speaking, such, the conversional efficiency of a dynamo is, as I understand it

$$\frac{\text{total electrical output}}{\text{total mechanical HP.}}$$

what he gave as such was

$$\frac{\text{electrical work in external circuit}}{\text{work transmitted to dynamo neglecting friction}}$$

I am yours truly,

RICHARD P. FUGE.

4, The Terrace, High-road, Chiswick, W., Feb. 8, 1887.

TOOTHED GEARING.

TO THE EDITOR OF ENGINEERING.

SIR,—I am surprised that any one should now reopen the question of chord *v.* arc pitches. A moment's consideration of the primary idea of a pair of toothed wheels, namely two smooth discs revolving in peripheral contact, ought to be sufficient to at once dispel the chord pitch idea from the mind of any engineer.

I think I shall violate no confidence when I state that ten years ago I called Mr. Molesworth's attention to the error in his seventeenth edition. Mr. Molesworth replied, and whilst fully admitting the error as applied to general case, stated that the tables, &c., there given were intended for a special case, but that misconception had arisen from lack of full information being given therewith, and he intended to delete the whole in next new edition. Such was, if I recollect rightly, the substance of the reply.

"Mill Gearing," by Thomas Box, is an excellent book of reference. Let "Discipulus" obtain it. I am of opinion that a length of tooth certainly not more than two-thirds pitch is amply sufficient for all purposes, though a clever old engineer once remarked that he would make teeth work as long as his arm. He certainly did continue to send out some longish specimens, many of which no doubt are working well and in good condition in the valley of East Lancashire. Still a short tooth fulfils all necessary requirements.

I am, Sir, yours truly,

W. H. BOOTH.

27, Exchange-buildings, St. Mary's Gate, Manchester.

TELEPHONES IN GERMANY.—The telephone wires are daily increasing in number and length over and around the Prussian capital. The total length of the wires is, in round numbers, 12,000 kilometres, or very nearly the diameter of the earth. There are nine exchange offices in the city, and 10,000 speaking tubes. The number of subscribers in Berlin is about 6000, who hold an average of 100,000 conversations daily. In the neighbourhood the number of conversations averages daily between 1500 and 2000. The Berlin telephone system employs 300 officials. The furthest point with which Berlin is directly connected is Hanover, distant 340 kilometres, or about 215 miles.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Wagon Companies' Meetings.—Half-yearly meetings of the shareholders in the Wakefield Rolling Stock Company (Limited), and the Yorkshire Railway Wagon Company (Limited) have been held at the Corn Exchange, Wakefield. The Rolling Stock Company's meeting was held first, and was presided over by Alderman Watson, the chairman of the directors, and in moving the adoption of the report and the payment of a dividend of 4 per cent., less income-tax, he stated that trade was very quiet, and competition very keen, and he believed that the profits of wagon companies would be much less in the future than they had been in the past. Mr. Henry Robinson, the chairman of the Yorkshire Railway Wagon Company, presided over their meeting, and moved the payment of a dividend of 5 per cent., as against 4*l.* 3*s.* 4*d.* last half-year. He was pleased they were able to pay a slightly increased dividend, which was due not so much to increased rentals of wagons as to a reduction in expenditure.

Scarborough Gas Company.—The directors have issued their statement of accounts and balance sheet for the half-year ending December 31st, 1886, in which they congratulate the proprietors upon the excellent results exhibited by the half-year's operations. The balance of net revenue (being the net earnings after deducting interest on mortgages, &c.) was 5506*l.* 4*s.* out of this sum, after providing for the payment of the preferential dividend on 5*l.* per cent. preference stock. The directors recommend the payment of the maximium dividends for the half-year upon all other stocks of the company, payable on and after the 17th instant. The payment of such dividends would absorb the sum of 5036*l.* 11*s.* 5*d.*, leaving a balance of 469*l.* 12*s.* 7*d.* to carry forward.

Hull Dock Company.—The annual meeting report of the directors of the Hull Dock Company states that the directors have been compelled during the past year to carry on a keen competition with the Hull and Barnsley Railway and Dock Company. Prior to the opening of Alexandra Dock on the 16th of July, 1885, the Hull and Barnsley Company issued a schedule of rates and charges about thirty per cent. lower than those hitherto in operation at this port. It consequently became necessary for the Hull Dock Company, from time to time, to reduce its rates and charges to such a level as would enable it to secure shipping rather than see its trade obstructed. Efforts had been made to terminate the competition, and the directors had made two propositions, the first of which was to take over the working of the Alexandra Dock and allow the Hull and Barnsley Company 10 per cent. of the combined net profits of the two dock estates. The second proposition was to adopt the principle known as the joint-purse system, thus fixing uniform dock charges. Both proposals were rejected. The only counter proposition made by the Hull and Barnsley Company being one involving a large and permanent reduction of revenue which was inexpedient in the interests of the shareholders. The directors deeply regretted that, owing to the causes mentioned and to the general depression of trade, the company could not pay a further dividend this year on its preference and ordinary stocks.

York Water Works Company.—The half-yearly ordinary meeting of the shareholders of the York New Water Works Company has been held. The directors recommended that a dividend of 5*s.* per share on the preference shares, being at the rate of 5*l.* per cent. per annum; a dividend of 8*s.* per share on the ordinary shares, being at the rate of 8*l.* per cent. per annum; a dividend of 5*s.* per share on the new shares, 1878 and 1879, being at the rate of 5*l.* per cent. per annum for the past half-year, be declared, and that the same respectively be paid, without deduction for income tax, on and after the 8th day of February next. This was carried.

Yorkshire College Engineering Society.—A meeting of this Society has been held in the engineering lecture-room of the Yorkshire College, Professor A. Barr in the chair. A short communication on a broken crankshaft was made by Mr. E. J. Silcock, and a discussion as to the cause took place. Mr. Wilson Hartnell, M.Inst. M.E., then read a paper on "The Governing of Engines by the Regulating of the Expansion." A discussion, in which Messrs. Drake, Whitehouse, Tempest, Silcock, Gardner, the chairman, and others took part, brought the meeting to a close with a vote of thanks to Mr. Hartnell for his interesting paper.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a fair attendance on 'Change, and the tone of the market was better. No. 3 Cleveland pig was quoted 36*s.* 6*d.* per ton f.o.b. Tees this month and for delivery over a few months, 37*s.* Shipments are improving, being this month up to date 13,000 tons, as compared with 8000 tons to corresponding time in January, and 11,000 tons at the corresponding period last year. The Board of Trade Returns just published show an expanding foreign trade, and the latest advices from the Continent and America give cheering accounts of the improvement in the iron and steel trades there at advancing prices. Our home trade also continues to mend, and during the past fortnight some good orders for new steamers have been booked by builders at the north-eastern ports. Hematite pig iron is firm at 49*s.* to 49*s.* 6*d.* per ton for Nos. 1, 2, and 3 f.o.b. east coast ports. Manufactured iron is unchanged. Ship plates are quoted 4*l.* 15*s.* to 4*l.* 17*s.* 6*d.* per ton; angles, 4*l.* 10*s.* to 4*l.* 12*s.* 6*d.*; steel plates, 6*l.* 5*s.* to 6*l.* 10*s.*; angles, 5*l.* 15*s.* to 5*l.* 17*s.* 6*d.*, all less 2½ per cent. at works. Steel rails are selling at 4*l.* 7*s.* 6*d.* per ton f.o.b.

The Make and Disposal of Pig-iron in Cleveland.—During

the month of January there were 89 of the 155 blast furnaces of the Cleveland Ironmasters' Association in operation, and they produced 192,990 tons of pig-iron; a decrease of 303 tons on December. The total stocks now stand at 651,517 tons; a decrease of 928 tons. It is expected that as the shipping season approaches the stocks of makers will considerably decrease.

Engineering and Shipbuilding.—Engineers and iron-founders keep fairly-well employed, and have more contracts in hand than they had a year ago. The shipyards are rather busier.

The Steel Trade.—The steel trade continues active, but it is matter for regret that the men at Messrs. Bolckow, Vaughan, and Co., Eston Steel Works, near Middlesbrough, who a fortnight ago struck for an advance of 10 per cent. in their wages, are still idle. Efforts have been made to arrange a compromise but they have failed. There is, however, every reason to believe that work will be resumed on Monday, the employers having conceded an advance of 2½ per cent. for eight weeks, and agreed to refer the further consideration of the subject to an accountant. We stated at the beginning of the strike that it would not extend over more than a fortnight at the longest, as the men were not organised. The steel-workers are now organising and they may ultimately join the Board of Arbitration.

The Coal and Coke Trades.—Coal and coke are firm, owing chiefly to the great stoppage of work by the strike in Northumberland. Various attempts have been made to settle the strike, but they have all failed. Thousands of men are idle, and both employers and operatives are suffering in consequence. If a proper Court of Arbitration were established there would be no need for enforced idleness and loss such as is going on in Northumberland.

MANGANESE STEEL BOLTS.—A new manufacture of manganese steel is being introduced by Messrs. Pfeil and Co., of 145, St. John-street, Clerkenwell, E.C., principally in the form of bolts. The new metal, to which the name "retort steel" is applied as a trade mark, is exceedingly tough, and bolts made from it can be doubled in the threaded part through 120 degs. round their own diameter without showing a crack. We have seen half a dozen bolts, taken haphazard from a heap, subjected to this severe punishment, and all have borne it equally well. Three test pieces, made from bars of 1⅛ in., 1½ in., and 1¼ in. diameter respectively, have been tested by Professor Kennedy at University College with the following results:

Dimensions.	Limit of Elasticity.	Breaking Load.	Ratio of Limit to Break.	Extension on Whole Length of 10 in.	Reduction of Area at Fracture.
area. sq. inch.	tons per sq. in.	tons per sq. in.		per cent.	per cent.
.873	19.40	29.35	.661	25.7	55.0
.874	17.22	28.80	.598	27.8	54.5
.506	19.60	27.99	.700	23.7	57.1

The bolts appear to be well worth a practical trial, particularly in work subject to constant jars, and where the failure of a single fastening may entail serious consequences. Nothing is more annoying than to have a bolt snap off as it is being tightened, or a stud fly on being set; with this metal there appears to be no chance of these awkward occurrences.

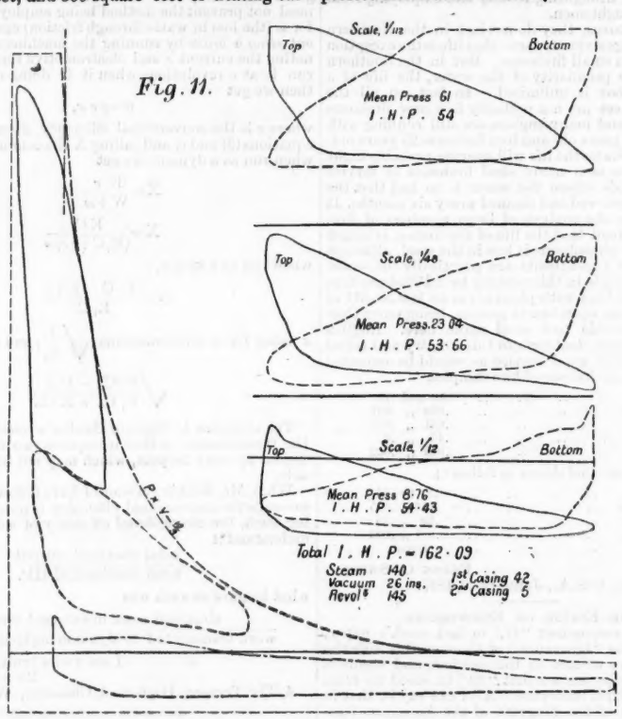
KING'S COLLEGE OLD STUDENTS' DINNER.—The annual dinner of the old students of all the departments of King's College was held on Friday the 4th, at the Holborn Restaurant, and was attended by 180 old students and their guests. The chair was taken by Sir Edward Clark, Q.C., M.P., the Solicitor-General; and amongst them present were the Rev. Prebendary Ware, D.D., who succeeded Dr. Barry (now Bishop of Sydney); the Rev. T. H. Stokoe, General Sir R. Wilbraham, K.C.B.; Sir R. Rawlinson, C.B., C.E.; Mr. J. G. Talbot, M.P.; Mr. Shiref Will, Q.C., M.P.; Sir C. Douglas Fox, C.E.; Mr. W. H. Preece, Professor Shelley, Professor Adams, F.R.S.; Professor Castle, Professor Henry Robinson, C.E.; Professor Hughes, Messrs. Peter Brotherhood, C.E.; R. H. Tweddell, C.E.; A. E. Carey, John Hunter, E. K. Burstal, &c., Messrs. F. S. Courtney, C.E., S. H. Terry, C.E., and W. E. Lines, the three last with Professor Robinson being members of the dinner committee who have been successful in raising the attendance from 82 last year, when the dinner was held in the college hall, to 180 on the present occasion, and it is hoped next year that the attendance of old students in the applied science department, which numbered about 40 on Friday last, will be still further increased. The usual toasts, "Church and Queen," and "King's College," followed. Dr. Ware, in replying for the College, said that it may not be generally known that upwards of 2000 students of all departments passed the gates of King's College every week; he then alluded to the good work being done in King's College Hospital, and in the engineering workshops and laboratory. The other toasts were, the "Professors," "Lecturers," and "Guests." In replying for the guests Sir R. Rawlinson hoped that the young men who were fortunate enough to be able to attend lectures at King's College would realise their advantages to the full. The health of the Committee then followed, and in reply Mr. Henry Robinson and Mr. W. E. Lines, the hon. secretary, hoped that they would be even more successful in bringing old friends together in the future, than on this occasion, as such meetings must be for the good of the college and each other.

ENGINES OF THE STEAM YACHT "GLADIATOR."

MESSRS. RAMAGE AND FERGUSON, of Leith, have lately constructed for Mr. Richard Martin, of London, a very handsome auxiliary screw steam yacht named the Gladiator. This vessel is 113 ft. keel aforerake, with 20 ft. beam and 13 ft. depth moulded, and is fitted with a Bevis patent feathering propeller, driven by a set of triple-expansion engines designed and constructed by the same firm. General views of the engines and boilers were given on pages 104 and 105 of last week's issue, and additional views will be found on the two-page plate of the present number and on the present page.

The diameters of the cylinders are 9½ in., 15 in., and 24½ in., with 18 in. stroke. They are supplied with steam at a working pressure of 150 lb. per square inch, by a steel cylindrical tubular boiler 8 ft. 6 in. in diameter by 7 ft. 9 in. long, with one of Fox's patent corrugated furnaces. This boiler has a firegrate area of 15 square feet, and 500 square feet of heating surface. The particulars of the various pipes shown and numbered in the views are given in the subjoined Table.

Fig. 11.



No.	List of Pipes.	Material.	Bore. in.	B.W.G.
Steam Pipes:				
1	Main steam	Copper	2¼	8
2	Steam to starting valves	"	1	12
3	" donkey	"	1	10
4	" whistle	"	1	10
5	" and water to gauges	"	1¼	9
6	" to windlass	"	1	12
Exhaust Pipes:				
7	Main waste steam	"	4½	16
8	Bottom blow-off	"	1½	9
9	Surface	"	1½	9
10	Exhaust from donkey	"	1¼	16
Water Pipes:				
11	Circulating suctions	"	3½	12
12	" discharge	"	3½	12
13	Air pump "	"	3½	12
14	Bilge discharge overboard	"	1½	14
15	Main feed discharge	"	1¼	9
16	" suction from hot-well	"	1½	14
17	Donkey " sea and bilge	"	1½	14
18	" " hot-well	"	1½	14
19	" discharge to three-way cock	"	1½	14
20	" " boiler	"	1½	9
21	" " on deck	"	1½	14
22	" " to condenser	"	1½	14
23	" " overboard	"	1½	14
24	Fireman's water service	"	1½	16
25	Drain pipe from safety valves	"	1	15
Bilge Pipes:				
26	Circulating bilge suction	Lead	2	
27	Donkey suction from bilge	"	1½	
28	Suction from aft hold	"	1½	
29	" engine-room	"	1½	
30	" fore hold	"	1½	

The principal feature in the machinery is the novel design of the valve gear, and this being the first set of triple-expansion engines fitted in this way, we think the illustrations given will be of some interest to marine engineers. There are now about a dozen different patterns of valve gear for triple-expansion engines, all designed with a view to economise space, both fore and aft and athwartships, and we believe the arrangement adopted in the Gladiator will be found quite equal in this respect to any of the other systems. While, however, attaining this object it will be seen on reference to Figs. 5 and 6 that the slide valves being placed at the back, and the cylinders being supported by wrought-iron columns, much light is admitted to the starting platform and the front of the engines being open, free access is obtained to every bearing about the valve gear, as well as to the larger working parts of the engines. The valve gear is of the compound type, *i.e.*, the lap and lead motion is derived from the piston rod crosshead and the opening to steam from the eccentric. As designed there is a quick opening and shutting of ports, the valve "dwelling" when full open, due to the two motions counteracting each other in this position. There is a large range of expansion without undue compression, the "leads" remaining constant at all grades, the port opening, compression, and release are all practically equal at both ends of the stroke, or can be altered if so desired, thus giving in every sense a perfect distribution of steam.

A trial trip was made on 4th October last at the measured mile in Gullane Bay, Firth of Forth, during a strong breeze and with a considerable sea on, a speed of 8½ knots was attained, and as will be seen from the diagrams, the engines indicated 162 horse-power at 145 revolutions. The power being equally distributed between the cylinders being for the

	Horse-Power.
High-pressure cylinder	54
Intermediate pressure cylinder	53.66
Low-pressure cylinder	54.43
	162.09

The engines worked with remarkable steadiness, and on the run to Portsmouth on the 5th October, when the vessel encountered very severe weather during the whole of the passage, the engines never had to be stopped, and the valve gear proved to be quite a success.

Messrs. Ramage and Ferguson are fitting the same gear to a set of triple-expansion engines of about 900 indicated horse-power.

TASMANIAN COAL.—Some of the Mount Nicholas Coal Company's coal from an 8 ft. seam has been tried for railway purposes with satisfactory results.

NEW ZEALAND RAILWAYS.—The railway revenue of New Zealand in the first twenty-eight weeks of the current financial year was 501,493*l.*, as compared with 540,675*l.* in the corresponding period of 1885-6, a decrease of over 39,000*l.* The working expenses amounted in 1886-7 to 380,446*l.*, as against 372,931*l.*, an increase of nearly 8000*l.* in 1885-6. The net profit was accordingly less by 47,000*l.* The extent of line in operation in 1886-7 was 1654 miles, as compared with 1496 miles in 1885-6. The traffic shows an increase of 77,235 in the number of passengers, of 11,235 in the number of parcels, &c., and of 54,391 in the number of livestock carried; but a decrease of 67,701 tons in the quantity of goods conveyed. The falling off was in grain, timber, firewood, and general merchandise.

RUNG'S PNEUMATIC ROTATION INDICATOR.

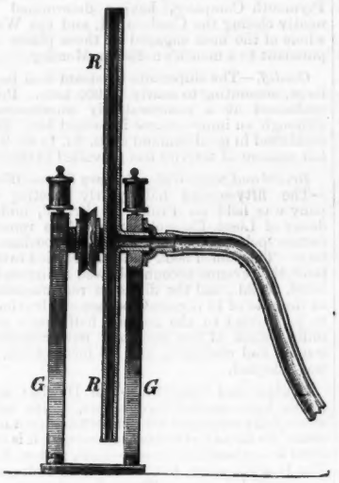


FIG. 1.

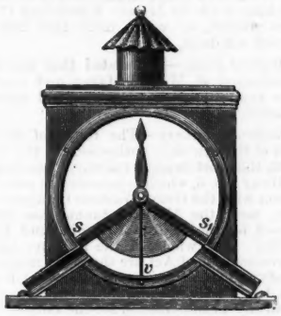


FIG. 3.

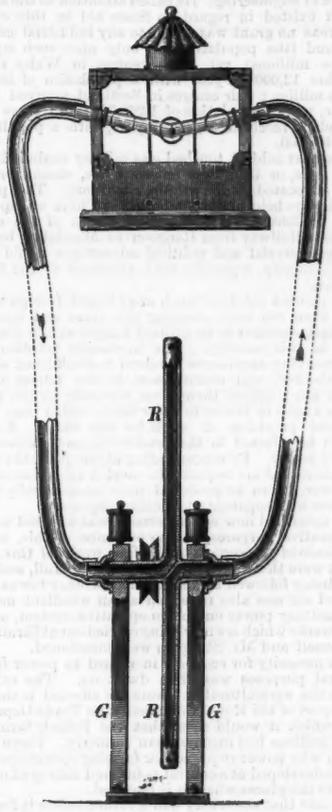


FIG. 2.

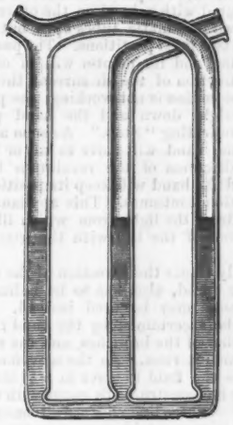


FIG. 4.

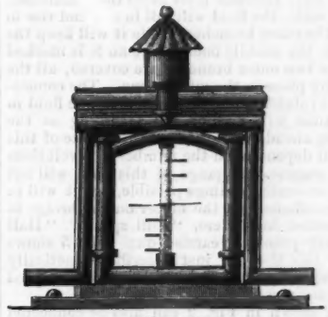


FIG. 5.

CAPTAIN G. RUNG, of the Danish Royal Artillery, and sub-director of the Meteorological Institute, Copenhagen, has recently brought out an ingenious pneumatic rotation indicator. This indicator differs very materially from the strophometer, the tachometer, &c., and has the advantage over these, that it enables the speed of an engine to be ascertained at a very considerable distance, while the former appliances are confined to the immediate neighbourhood of the engine, or, at most, to the limits within which rotation can be transmitted by mechanical means, such as belting, &c.

If a piece of india-rubber hose is swung round by the hand, the air in the swinging portion of the hose will be driven out by the centrifugal force. If the hose is open at the centre of movement, other air will enter and a current will arise; if the hose is closed the air within it will become rarefied, and this will happen in distinct proportion to the speed of the open end of the hose. This speed depends partly on the diameter of the circle formed by the end of the hose and partly on the number of revolutions within a certain time, say a minute. With a fixed diameter the difference between the pressure of air outside the hose and that inside it, at its centre of rotation, will be the measure of the number of revolutions of the hose per minute. This can be read by continuing the hose beyond the centre of rotation and connecting it with a manometer of some sort, *e.g.*, a V-shaped glass tube, filled with water, the one end of which is connected with the hose, while the other is open. The difference in the height of the water in the two branches will then illustrate the difference in the pressure of air in millimetres of water pressure.

When the rotary hose is connected through a tube, which may be of great length, with a regular vacuum gauge, the hand of this will assume a fixed position, as soon as the rotary speed of the hose has become uniform. If the diameter of the circle formed by the hose remains the same, the movement of the hand will increase proportionately to the square of the number of revolutions. If the number of the revolutions remain unaltered, and the length of the swinging hose is increased, the air within it will also become rarefied proportionately to the square of the diameter of the circle formed by the end of the hose.

The mathematical formula will also show

$$H = \frac{\rho \pi D^2 O^2}{2.60^2} K,$$

where

H is the pressure expressed by millimetres of water.
D the diameter of the circle described by the end of the hose.
ρ the weight of a cubic centimetre of air.
O the number of revolutions per minute.
K a constant fixed by experiment.

The value of ρ varies with the density of the air, which is influenced both by the atmospheric pressure and by the temperature, but this can be compensated by special arrangements.

The pneumatic rotation indicator consists of two principal parts: the rotator, which takes the place of the hose, and the indicator or the manometer. The rotator may assume different shapes; one of the simplest constructions is shown in Fig. 1. R is a piece of gas-pipe, which revolves on an axis, the one end of which is hollow and connects the interior of the pipe with a pneumatic tube, which again acts upon the indicator. A small pulley on the other end of the axis connects the rotator with the machine, the speed of which is to be ascertained. As many indicators as desired can be connected with the pneumatic tube. Experiments have proved it to be immaterial, whether one or both ends of the pipe (as in the engraving) are open, nor does it make any difference, if a larger number of pipes are fixed to the axle; the same speed will always produce the same rarefication.

It has already been mentioned that the factor ρ is dependent upon the density of the air, which of course varies with the temperature and the atmospheric pressure. Unless this is taken into consideration, the indicator would show a greater number of rotations with a high barometer and low temperature, and a smaller speed with a low barometer and high temperature, than is actually the case. What is wanted is that H with the same number of revolutions (O) always remains the same, even if ρ should change, or, in other words, the length of the rotary pipe must be altered according to the density of the air. This can be done by the aid of the annexed Table, where the figures 0—10 signify

—	730 mm.	740 mm.	750 mm.	760 mm.	770 mm.
deg. 0	6	7	8	9	10
5	5	6	7	8	9
10	4	5	6	7	8
15	3	4	5	6	7
20	2	3	4	5	6
25	1	2	3	4	5
30	0	1	2	3	4

the position of a small sliding pipe placed outside the rotary pipe, and which can be pushed further from or nearer to the axis, thereby altering the length of the pipe.

So far the question has only been of the speed, and not of the direction of the rotation. The indicator can, however, be so constructed that it will also demonstrate this point, which is of importance under many circumstances, more especially on ships. By the aid of Captain Rung's indicator, the captain on the bridge can ascertain whether his orders "Ahead," "Astern," or "Stop" have been immediately carried out. This end is obtained in the following manner:

Experiments have proved that it is immaterial whether the aperture is at the end or on the side of the pipe, as long as the same speed is maintained. The only exception is, when the aperture is on the side, and is so placed, that it, during rotation, is subject to the resistance of the air. If a slanting partition is placed in the middle of the pipe, and if both axes are made hollow (see Fig. 2), the result is two independent pipes, each with its pneumatic tube. These two pipes are closed at the ends, but have each an aperture on the same side, so that one of these holes is always turning against and the other from the direction of the rotation, and consequently change their position, whenever the rotation is reversed. If the two pneumatic tubes are connected with each other, the revolution of the rotator will cause an air current to pass through the tube, and the direction of this air current depends upon the direction in which the rotation is revolving. It now only remains to observe the direction of the air current, and this can be done in different ways. One may, for instance, place in the tube that connects the two axles a glass tube bent downwards (see Fig. 2). In this tube is placed a ball of the pith of the alder tree; when there is no rotation, this ball will of course remain at the bottom of the bent and indicate "Stop;" an air current in one or the other direction will carry the ball to either end of the glass tube (where it is stopped by a small cross of wire). The letter H or the letter S will then show whether the engine is going ahead or astern. As possible dampness on the inside of the glass tube might interfere with the movements of the ball, preference is given to the following arrangement.

Instead of the glass tube a flat box, placed on its side, is used for connecting the two parts of the pneumatic tube; the lid and the bottom of the box are of glass, the latter of ground glass (Fig. 3). From the centre

of this box two fixed partitions (s, s_1) proceed, and between these a third partition (v) of some very light material (*e.g.*, aluminium) is so placed that it can swing freely. It is connected with a hand on the other side of the box. The two pneumatic tubes open out into the box close to the two fixed partitions. The position of the loose partition and its pointer will of course depend upon the direction of the air current through the tubes; when the engine is not working, the partition will hang straight down and the hand point straight upwards, indicating "Stop." As soon as the engine is started the hand will move to left or right according to the direction of the revolution being ahead or astern, and the hand will keep its position as long as the revolution continues. This appliance is placed outside a lantern, the light from which illuminates the dull bottom of the box with the letters H and S.

This appliance only shows the direction of the revolution; in case the speed, also, has to be indicated, a fluid pressure gauge may be used instead. The direction can then be ascertained by the fluid rising in the one or the other of the branches, and the speed by the height to which it rises. As the movement of the ship might cause the fluid to move in a U-shaped tube, Captain Rung has constructed a gauge with three branches (see Fig. 4). These branches are all connected at the base, while the two outside ones are joined at the top, and, when united, again connected with the one pneumatic tube. The other is connected with the central branch. When the engine is not working, the fluid will have the same level in all three branches. If the vessel rolls, the fluid will fall in one and rise in the other at the outer branches, while it will keep the same level in the middle one. Here an S is marked for stop. The two outer branches are covered, all the readings taking place in the middle one. The connections with the rotator are so arranged that the fluid in the middle tube will rise or fall according as the engine is going ahead or astern, and the degree of this rise or fall will depend upon the number of revolutions made by the engine. A gauge of this kind will not render very accurate readings possible, but it will in most cases be sufficient for the officer on the bridge to ascertain whether his orders, "Full speed," "Half speed," &c., are promptly carried out. Fig. 5 shows a manometer like the one just described practically applied in a shape which is particularly well adapted for merchant steamers.

The rotator shown in Fig. 2 can also be connected with a self-registering apparatus, which can furnish evidence in collision cases, &c., as the engine virtually tells its own tale as to whether and when it was stopped and reversed.

Captain Rung's indicator is already in use on several steamers, and is giving satisfaction. From the commander of the Danish warship Iylland, where the distance from the engine-room to the bridge is about 100 ft., a flattering testimonial has just been received, and the new Danish ironclad Iver Hoitfeldt is being fitted out with no less than eight of these indicators in different places. They are also being successfully used for the testing of cream separators, where a very great speed is reached, and it is under contemplation to make a special size for centrifugal dairies. The indicators are being introduced in this country by Messrs. Capito and Hardt, of 63, Queen Victoria-street, E.C.

SOCIETY OF ENGINEERS.

THE first ordinary meeting for the present year of the members of the Society of Engineers was held on Monday evening, February 7th, at the Town Hall, Westminster. The chair was first occupied by the retiring President, Mr. Perry F. Nursey, who presented the premiums of books awarded for papers read during the past year. These were—the Bessemer Premium, to Mr. Percy Tarbutt, for his paper on "Liquid Fuel;" the President's Premium, to Mr. G. B. Jerram, for his paper on "River Pollution caused by Sewage Disposal;" and a Society's Premium to Mr. E. S. Bellasis, for his paper on "The Roorkee Hydraulic Experiments." The death of Sir Joseph Whitworth, an hon. member of the Society, was announced, and a resolution passed, offering to Lady Whitworth the condolence of the Society. The retiring President then introduced the President for 1887, Professor Henry Robinson, who proceeded to deliver his inaugural address. He dwelt at some length on the essential conditions that had to be observed in preparing and training a young man for the engineering profession. Many youths are sent almost direct from school into workshops; whilst on the other hand, many pursue their theoretical studies apart from opportunities of observing the practical application of their knowledge. In the former case, the youth may become a skilful mechanic, but will lack breadth of knowledge. In the latter, the youth acquires a higher proficiency in pure science than may be required for actual engineering work, and is wanting in the leaven of practical knowledge. The brain and the muscles, or the mind and the hands, should work together.

He urged the necessity for State aid towards higher technical education which a Royal Commission in 1872 had recommended for the endowment of colleges like King's College and University College, London, and others in great industrial centres. The necessity for this is confirmed by the recent report of the Royal Commission on Trade Depression. He hoped to see the establishment of a teaching university for London, and conferring a degree of engineering. He called attention to the anomaly which existed in regard to State aid in this country. Whereas no grant was given to any industrial centre in England (the population of only nine such equalling twelve millions), yet three centres in Wales received together 12,000*l.* a year with a population of less than half a million; four centres in Scotland received 16,000*l.* a year, with a population of 1,260,000; and three centres in Ireland received 25,500*l.* a year, with a population of only 400,000.

The next subject touched was railway engineering, and light lines, or tramways (either horse, steam, or cable) were advocated under certain conditions. The prospect of railways being shortly adopted in China was spoken of with confidence, as also the extension of the existing Burmese Railway from Rangoon to Mandalay, by which both commercial and political advantages would accrue to this country, especially with reference to the Chinese Empire.

He pointed out how much more frugal foreign workers were than our own, enabling the plant and machinery of a manufacturer to be utilised longer on the Continent than in this country. The increasing substitution of labour-saving appliances involved a diminished demand for labourers and disturbances in the labour market, which must adjust themselves naturally by the shifting of the excess of labour to other fields, rather than by any artificial provision of work by the State. Economy should be effected in the production and utilisation of motive power. By concentrating at one point the engines and plant that are requisite to meet a large consumption of power, it can be produced more economically than is the case with separate and smaller engines.

He described how water pressure was adopted to power co-operative purposes, and as evidence of this, mention was made of the success of the first works of this nature, which were those he had carried out at Hull, and which were being followed by similar ones in other towns. Compressed air was also relied on as an excellent means of transmitting power on the co-operative system, and the large works which are now being carried out at Birmingham by himself and Mr. Sturgeon were mentioned.

The necessity for economy in regard to power for agricultural purposes was then dwelt on. The extent to which the agricultural interests are affected is shown by the report of the Royal Commission on Trade Depression, from which it would seem that the British farmer has forty millions less income than formerly. There was no reason why power required for farming operations should not be developed at a central point, and conveyed over the farm to the places where it is required.

He said that electricity had a future before it for transmitting power. The employment of electricity for purposes of locomotion was mentioned. He referred to the Newry and Bessbrook Electric Railway, and to the electrical tram engine on Elieson's system, on the Manor Park line of the North Metropolitan Tramways Company, as instances of the successful use of electrical energy for tractive purposes. The removal of the hampering restrictions which the Board of Trade in 1882 imposed on electric lighting orders was advocated.

Reference was next made to the establishment of county boards, a difficulty to be overcome being the administration of urban and rural affairs by one central authority. Sufficient agreement now exists in reference to much-needed amendments of the Public Health Act of 1875, and of the Rivers Pollution Act of 1876, to enable them to be carried through Parliament without difficulty if only an opportunity was given. The most recent experiences in the questions of water supply and sewage disposal were touched upon.

A strong expression of opinion was given as to the necessity for such a modification of existing legislation as would bring the letting or selling of houses under more stringent control as regards health. It was pointed out that it was an offence, by Act of Parliament, to sell food which was unfit for consumption, and which was a danger to health. In like manner it should be made an offence to sell or let a house when in an insanitary condition, it being equally dangerous to health.

At the conclusion of the address, a cordial vote of thanks to Professor Robinson was proposed and unanimously passed.

AN INDUSTRIAL MUSEUM AT JEKATERINENBURG.—It is a well-known fact that the Russian Government does all in its power to encourage native industries, a very far carried protection being one of the means adopted. As another proof can be mentioned a new scientific industrial museum to be opened next summer at the town of Jekaterinenburg. It is expected that this new institution will be very beneficial for the further development of the mining and engineering industries of the Ural Mountains.

MOSQUITOES AND TROUT.—According to a recent bulletin of the United States Fish Commission, young brook trout are killed by mosquitoes in certain streams of Colorado. For example, in the Tumichie Creek, of Gunnison Valley, when the young trout come to the surface, the mosquito on the watch digs his bill into the brain of the fish and sucks it. The fish seems unable to escape, and when the insect flies away, it turns over dead. In the course of half an hour, one observer states that he saw over twenty trout killed in this manner. The locality was near the snow-line, and the observation, if corroborated, will serve to direct the attention of those interested in fish culture to an apparently unsuspected enemy of young fishes.

NOTES FROM THE SOUTH-WEST.

A Merthyr Colliery Closed.—The mortgagees of the Plymouth Company, having determined upon permanently closing the Coedcoe Pit, and the Wain Level, the whole of the men engaged at these places ceased work, pursuant to a month's notice on Monday.

Cardiff.—The shipments of steam coal last week were large, amounting to nearly 60,000 tons. Prices have still continued at a comparatively unremunerative level, although an improvement is looked for. House coal has continued in good demand at 8s. 6d. to 8s. 9d. per ton. A fair amount of activity has prevailed in the iron trade.

Bristol and South Wales Railway Wagon Works (Limited).—The fifty-second half-yearly meeting of this company was held on Friday at Bristol, under the presidency of Lieut.-Colonel Savile. The report of the directors spoke of the past half-year's business as satisfactory. The sum of 500*l.* had been carried to the contingent fund, the revenue account showed a disposable balance of 5540*l.* 2s. 8d., and the directors recommended a dividend at the rate of 10 per cent. per annum, leaving 425*l.* 2s. 8d. to be carried to the current half-year's account. The rolling stock of the company now consisted of 11,033 wagons and carriages, and 13 locomotives. The report was adopted.

Dowlais and Cyfarthfa.—The Dowlais and Cyfarthfa works have secured two orders, which will keep both works fully employed for the next eighteen months, or two years. So far as Cyfarthfa is concerned, it is stated that the order is a miscellaneous one—rails, plates, &c., for India. The Dowlais order, too, comes from India, and is largely for metallic sleepers. The order, it seems, was secured about a month since, and a specially constructed punching machine made by Messrs. Kitson and Co., of Leeds, has been erected, by which more than 200 sleepers can be turned out daily.

Milford Docks.—It is stated that the docks now being constructed at Milford Haven and covering an area of over 40 acres, will be completed and opened for traffic in August.

Rhymney Railway.—The report of the directors states that of the new lines authorised by the company's Act of 1882, the short branch railway, described in the Act as Railway No. 3, which is intended to perfect the communication with the Great Western Company's Vale of Neath line, near the Merthyr tunnel, has been finished and passed by the Board of Trade, and is now ready for traffic. The whole of the railways authorised by the above-mentioned Act are therefore now completed. The Pontypridd, Caerphilly, and Newport Railway Company has deposited a Bill in Parliament for powers to construct a railway in substitution for the railway authorised by its Act of 1882, and for other purposes, including a return of the Parliamentary deposit made for their Act of 1878. The Rhymney directors will oppose the granting of any fresh powers or privileges to the Pontypridd Company, until it has complied with its existing obligation to construct sidings at Pontypridd.

Swansea.—The shipping trade was fairly active last week. The coal shipments of the week amounted to 25,198 tons, and those of patent fuel to 5737 tons. The City of Manchester left last week for Newport News with 1000 tons of old rails, and 2000 tons of tin-plates. Last week's shipments of tin-plates amounted to 62,491 boxes.

Penarth and Cadoxton Railway.—On Monday the Taff Vale Railway Company virtually commenced this line. The section will be about 4½ miles in length, and will join the Barry Dock Railway near Cadoxton, and so enable the Taff Vale Railway Company to carry coal over its system for shipment at Barry. The contract has been entrusted to Messrs. Cogan and Hemingway, of Melton Mowbray, and as the works involve no difficulties, it is expected that they will be completed in twelve months. The engineers concerned are Mr. J. Williams and Mr. H. O. Fisher.

Locomotives on the Great Western Railway.—In the course of the half-year ending December 31, 1886, the Great Western Railway Company built twenty-four locomotives at the cost of revenue. The company's locomotive stock comprises 1600 engines and 805 tenders.

UNDERGROUND WATER IN TUNIS.—Search has recently been made in Tunisia for a subterranean water supply. Near Toser, which is famous for its palm groves, ancient Roman wells have been found; and an artesian bore giving 9000 litres of water per minute was completed. The discovery of this vast supply of water confirms the assertions of Strabo which have hitherto been disregarded. The water from the new well rose to a height of 4 metres and formed an artificial pond round the orifice 10 metres deep. The well now yields 2200 gallons per minute.

NEW QUEENSLAND RAILWAYS.—The new railways authorised by the Queensland Parliament during its recent session were the Fortitude Valley line, from the Roma-street terminus to Bowen Park, North Coast Railway (Gympie towards Brisbane), Mungarr to Gayndah, Bundaberg to Gladstone, Bowen to Townsville, Cooktown to Maytown, Cleveland branch, Normanton to Cloncurry, and deviations on the Northern Railway at Hughenden, and on the Fassifern branch line. The Warwick to St. George and the Laidley Creek lines were rejected by the Colonial Parliament. At the earnest request of the central district members, Mr. Miles at a late period of the session produced plans of the extension of the Central line from Barcaldine to the Thomson, and they were also agreed to. The Premier announced that the termini of the three Great Western trunk lines would be for the present Charleville, the Thomson, and Hughenden.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

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The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

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Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

FURNACES.

14,143. F. Siemens, London. Regenerative Gas Furnace for Continuous Reduction of Iron Ore. [8*d.* 6 *Figs.*] November 18, 1885.—At one end of the furnace are two sets of air flues A, A¹, and under them the gas flues G, G¹, communicating with the regenerative chambers R. Hot air and gas issuing from the one set of flues A and G form a flame which sweeps lengthways along the furnace and bends back before reaching the slope at the farther end, the products of combustion passing by the other set of flues A¹ and G¹ to one set of the regenerators. On alternating the current, the flame in like manner sweeps from

Fig. 1.

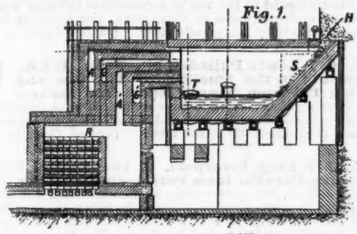
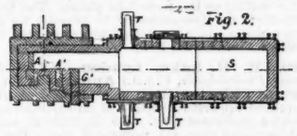
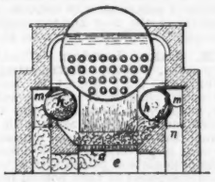


Fig. 2.



A¹ and G¹, and bends back, the products of combustion passing by A and G to the other set of regenerators. At the farther end of the furnace is a slope S, on to which is fed through a hole H in the crown of the furnace pulverised ore mixed with reducing and fluxing materials. The molten material collects in the deep basin bed, provided with several tap-holes T at different levels. The flues are so arranged, and the furnace so proportioned, that the flame acts by radiant heat alone. The slag is allowed to flow off continuously. (*Sealed November* 23, 1886).

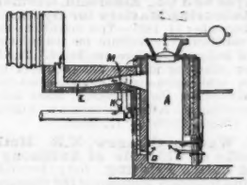
15,898. J. T. Griffin, London. (*J. W. Hatch, Rochester, New York, U.S.A.*) **Improvements in Furnaces, in Apparatus to be Used therewith, and in Utilising Solid and Gaseous Fuel therein.** [8*d.* 4 *Figs.*] December 24, 1885.—The illustration shows the application of this invention to a furnace employed for the generation of steam in a boiler. The furnace is provided on either side with a cylindrical retort *h*, mounted on journals, and accessible from the front of the furnace by doors through which the fuel is introduced into the retorts. These retorts are provided with openings *m* which normally communicate with the passages *n* leading to the space *e* below the grate, and these retorts are exposed to the heat of the fire burning on the grate *d*, so that the fuel in the retorts is roasted, causing



the more volatile portions to be driven off, passing through the opening *m*, the passage *n*, into the space below the grate, and passing through the fuel on the grate, to be consumed, thus adding to the heat derived from the fuel that is burning on the grate. When the fuel in the retort has become more or less coked, the retort is turned on its journals by means of a handle, so as to bring the opening *m* into the fire chamber in position to discharge the coked fuel on to the grate *d* where it burns in the usual manner. The retort is then restored to its normal position, fresh fuel is introduced into it, and the coking and discharging processes begin anew. By this means fuel is fed to the furnace without opening the furnace doors, or providing a direct passage to the space above the grate. (*Sealed December* 31, 1886).

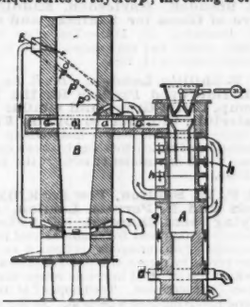
15,928. G. M. Cruikshank, Glasgow, N.B. (*A. Roth and G. Roth, Aschaffenburg, Germany.*) **Tuyeres for Forges or Hearths.** [8*d.* 2 *Figs.*] December 28, 1885.—The improved tuyere consists of a cylindrical or conical tubular part having a lateral inlet. The lower end of the cylindrical tube is closed by a door or shutter. The air passes out at the top through a plate having at or near its centre a group of conical holes or air passages. (*Sealed January* 4, 1887).

96. S. Fox, Leeds. Improvements in Apparatus for Generating or Producing and Utilising Gases. [8*d.* 5 *Figs.*] January 4, 1886.—A fire is first kindled in the generator A; the fuel being brought to incandescence throughout, and carbonic oxide being formed, steam is then turned through the nozzle E into the chamber below the fire, and by the decomposition of the vapour, hydrogen gas is given off with carbonic oxide and carbonic acid. The hydrogen and carbonic oxide now burn at the mouth of the furnace with great intensity, and by opening the valve N, air is admitted through the ports M to the gas in the combustion chamber L, causing it to ignite in that chamber, and the heat to be applied to the article under treatment—the illustration represents an arrangement adapted for flanging boiler flues—in any direction in which the gas is directed on to the same. If a very intense heat be desired, the air



blast through the nozzle D is then cut off, and only the hydrogen and carbonic oxid formed by the decomposition of the steam are burnt, producing a flame of higher calorific power, practically free from nitrogen. By varying the proportion of the air admitted by the valve N, the flame may be rendered neutral, oxidising, or reducing, at will. (*Sealed January* 21, 1887).

9711. A. J. Boult, London. (*E. Hamelius, Paris.*) **Improvements in Cupolas and Blast Furnaces.** [8*d.* 4 *Figs.*] July 27, 1886.—According to this invention gas developed in a gas generator A is introduced by a conduit D into the furnace B through openings *a*, arranged all round it. This gas is burned in an oblique zone of combustion by the air jets introduced through an oblique series of tuyeres *p*; the casing E of these tuyeres



is in communication with the lower wind box by a pipe. The gas generator A is fed by the blast of the furnace. The outer walls of the generator consisting in the lower part of firebricks, and in the upper portion of cast-iron rings, form, with their casing of sheet iron *g*, a series of boxes communicating with each other through openings *h*, and in which the blast is heated on its way to the furnace B. (*Sealed January* 11, 1887).

9941. C. Otto, Greifenhagen, Prussia. Improvements in Working Furnaces by Means of Compressed Air. [8*d.* 6 *Figs.*] August 3, 1886.—A is a vertical steam boiler with Field tubes, and provided with the inside furnace B. In the lower part of the boiler is formed by means of a fireproof lining, a shaft *b*, into which air is introduced below the grate. A gas furnace with generator is thus constituted, in which the main combustion takes place in and immediately above the narrow neck *b*¹. C is a fuel-feeder for introducing fuel into the furnace B whilst being under pressure. D is an apparatus in which the gases of combustion issuing from the furnace B are purified, and in which if they are of too high a temperature to be introduced directly into the hot air engine E, they are cooled down to the proper degree and impregnated with steam. While the fire is being raised, air is allowed to enter through the aperture *c*, and

Fig. 1.

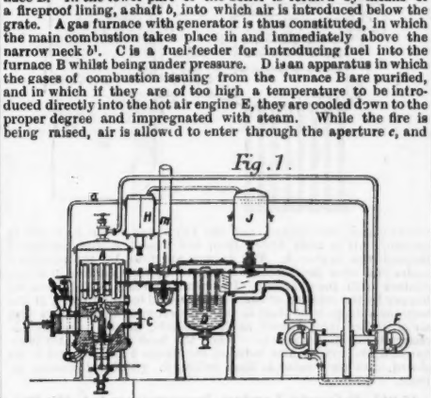
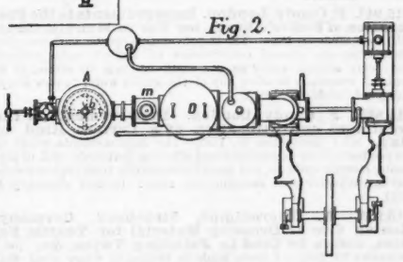
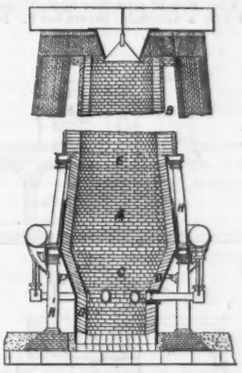


Fig. 2.



the gases of combustion issue through the pipe *m* into the chimney. When a sufficient steam pressure has been attained, communication is established between the boiler and the cylinder of the steam engine F. The steam engine then puts the air pump G in motion, so that compressed air is forced into the air vessel H and thence through the pipe *a* into the furnace B. At the same time the pipe *m* is closed by means of a valve, and the compressed gases of combustion, after having given off the greater portion of their heat to the boiler for the generation of steam, are compelled to pass through the apparatus D to the cylinder of the hot air engine E, where they are utilised expansively to assist the steam engine in its operation. The water evaporated in D is replaced from the reservoir J which is connected by a pipe with the air vessel H in order to produce therein the same pressure as in D. (*Sealed December* 10, 1886).

13,266. E. Walsh, St. Louis, Missouri, U.S.A. Improvements in Blast Furnaces. [8*d.* 1 *Fig.*] October 13, 1886.—A represents the furnace proper, B the furnace shaft, and C is the bosh which is brought down well within the zone of complete fusion and considerably lower than in the ordinary blast furnace. By the particular location of the bosh C and overhanging form of the furnace walls D between the bosh C and zone E, where the materials are in a more or less solid condition, the current of air from the tuyeres is more perfectly disseminated throughout the outer portions of the materials in the furnace than with ordinary wide boshes, and the adhesion of slag or semi-molten materials around the bosh is prevented. The bricks composing



the furnace walls D are laid with their joints inclined from the outside downwards towards the centre of the furnace, by which arrangement the bricks will gravitate inwards and pressing upon one another will close or consolidate the structure, thereby lessening the tendency of the walls D to bulge out, and also preventing the molten metal from escaping through the joints of the brickwork. The shaft B of the furnace is supported on a double row of columns H, H¹, p'aced one above the other at suitable distances apart around the outside of the furnace A. By this means the furnace A is rendered a separate construction from the shaft B, and can be easily got at for repairs or removal without disturbing the shaft B. (*Sealed January* 25, 1887).

MANUFACTURE AND TREATMENT OF IRON AND STEEL.

12,140. K. Kupfer, Berne, Switzerland. Process and Compound for Welding Cast Steel or Wrought Steel in Bars, without Heating to a White Heat, with Steel or Iron, and for Regenerating the Welded Steel. [4*d.*] October 12, 1886.—The welding compound is composed of borax rafia, fine steel filings, and sal-ammoniac, moistened with copaiba balsam. The regenerating powder consists of borax rafia, yellow prussiate of potash, colophony, sal-ammoniac, dragon's blood, and common salt. (*Sealed December* 14, 1886).

566. R. Hadfield, Sheffield. Production and Treatment of Steel. [6d.] January 13, 1886.—This invention has for its object the production of a new steely alloy or "chrome steel" by the addition of chromium, manganese, and silicon, to any ordinary pig metal or cast iron. (*Accepted December* 14, 1886).

12,271. W. H. Follett, Steelton, Penn., U.S.A. Improvements in Plant for Casting Steel Ingots. [11*d.* 9 *Figs.*] September 27, 1886.—The object of this invention is to lessen the labour and danger in casting steel ingots. Fig. 2 is a front view of the plant shown in Fig. 1. A represents an ordinary Bessemer converter provided with trunnions upon which it may be turned by means of rack gearing not shown. The pouring ladle C is supported at its front end on two wheels running on a track b^2. When the metal in the converter has reached the proper heat, the ladle C is moved by means of the piston of the hydraulic cylinder F over the mouth of the first ingot mould G

Fig. 1.

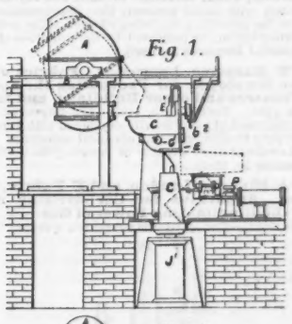
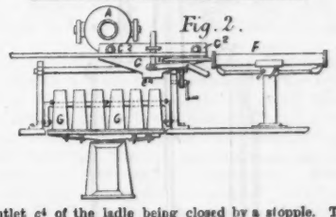


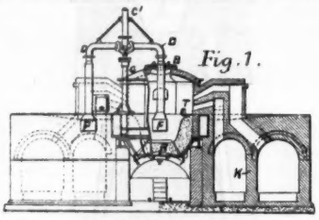
Fig. 2.

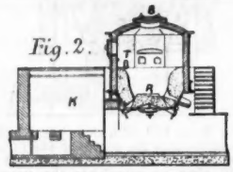


the outlet c^4 of the ladle being closed by a stopple. The converter B is now inverted and its contents turned into the ladle C. The stopple is then withdrawn by means of the bar and hand lever E^1, and the metal allowed to flow out into the first mould until it is filled. Then the stopple is replaced, and the ladle is moved by the hydraulic piston until the opening c^4 is over the mouth of the next mould and so on until all the moulds G are filled. The slag remaining in the ladle is readily turned out by rotating the handle E, turning the shaft c^1, and turning the ladle over backwards, the wheels c^3 leaving the track and the shaft supporting the entire weight of the ladle. The table H with the filled moulds is then raised by means of the hydraulic cylinder J^1

and the moulds are tipped over on to a tramcar or otherwise removed by means of the hydraulic apparatus P. (*Sealed January* 11, 1887).

12,541. R. Miller, Motherwell, Lanark, and N. E. Macoullum, Helensburgh, Dumbarton, N.B. Improvements in Furnaces for the Manufacture of Steel. [6*d*. 7 *Figs*.] October 2, 1886.—The furnace is octagonal in plan, and is fitted with a removable bottom R. Regenerators K are built at each side of the furnace. At the side of the furnace is situated a steam or hydraulic cylinder C, to the plunger of which is connected a telescopic blast pipe C^1, which at its lower end has two branch tubes D. The vertical part of each of the latter is protected with a covering of refractory material, and is furnished at its lower end with a detachable tuyere box F. In working the





furnace the molten pig iron is charged through the opening T, either direct from the blast furnace or from cupolas, the cover is removed from the opening B in the roof, the gas from the regenerators is turned off, and the air blast from the tuyeres F is gently turned on. The tuyere box F is then lowered by the plunger of the cylinder C until the tuyeres are several inches in the metal, and the blast is continued at an increased pressure until the metal is sufficiently decarbonised. The tuyere box F is then withdrawn and the gas turned on, samples of the metal are taken, and the process of manufacture is completed, as in the ordinary open-hearth furnace. (*Sealed January* 7, 1887).

MISCELLANEOUS.

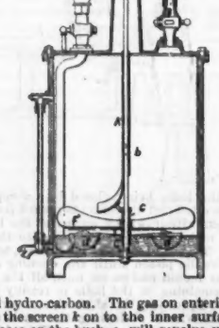
13,108. J. Y. Johnson, London. (*C. Dubois, Paris.*) **Extracting Sulphur from Materials Employed in the Purification of Gas or from other Materials Containing Sulphur.** [6*d*.] October 30, 1885.—The improved process consists in distilling or driving off the volatile impurities and subliming the sulphur in the presence of superheated steam or vapour. (*Sealed December* 3, 1886).

13,462. J. B. Spence, London. Improvements in the Manufacture of Sulphide of Zinc. [4*d*.] November 6, 1885.—According to this invention metallic zinc plates are suspended in a strong solution of caustic alkali, and coupled to iron plates introduced into the liquid. By means of the galvanic action thus set up, the zinc is rapidly dissolved, a solution of zincate of soda or potash, according to the alkali used, being formed. To this solution is added sulphide of sodium or potassium, which causes the zinc in solution to be precipitated in the form of sulphide of zinc. (*Sealed December* 3, 1886).

14,001. A. G. Brookes, London. (*T. S. Norvell, Boston, Mass., U.S.A.*) **Improvements in the Manufacture of Lactic Acid and Lactates.** [6*d*.] November 17, 1885.—The improvements relate to the preparation of a practically pure reagent for producing lactic acid, consisting in the successive impregnation of a series of culture baths (composed of starch, sugar, or dextrine, water, carbonate of lime, and vegetable nitrogenous matter) with lactic ferment, the impregnation of each solution from the preceding one being effected at the point of full height of fermentation, as indicated by the evolution of carbonic acid gas. (*Sealed December* 14, 1886).

14,949. T. Ransome, Lancaster. Fabrics or Materials to be Employed for Preventing the Spread of Fire in Theatres and other Buildings, and for other Purposes. [6*d*.] December 5, 1885.—The improved fabric or material is composed of metallic wire combined with fibrous material or paper pulp treated with any chemical substance by which the fabric is rendered more capable of resisting the action of fire. (*Sealed December* 10, 1886).

15,331. A. Kinnear, London, and E. Fahrig, Eccles, Lancaster. Apparatus for Carburetting and Increasing the Illuminating Power of Gas. [8*d*. 4 *Figs*.] December 14, 1885.—The apparatus contains a quantity of highly



distilled liquid hydro-carbon. The gas on entering the apparatus *a* deflected by the screen *k* on to the inner surface of the fan *f*, which, being loose on the bush *c*, will revolve under the normal pressure of the gas. The motion of the fan directly over the whole surface of the liquid hydro-carbon drives off the lighter vapour which is continually rising therefrom, and produces a thorough mixing and carburetting of the gas. b^1 is the outlet cock for the carburetted gas. The fan *f* is supported by floats *d*. (*Accepted December* 10, 1886).

15,337. Dr. H. Hassencamp and Farbenfabriken vorm F. Bayer and Co., Elberfeld, Germany. Manufacture of Colouring Matters for Dyeing and Printing. [6*d*.] December 14, 1885.—This invention has for its object to produce a satisfactory substitute for the relatively expensive preparations of indigo heretofore employed. The blueish green sulpho acid or colouring matters are produced by introducing benzyl groups into tetra-methyl-pseudo-leuco-aniline and its homologues, converting the benzylised bases into leucosulpho acids, and converting the latter into sulpho acid colouring matters by oxidation. (*Sealed December* 17, 1886).

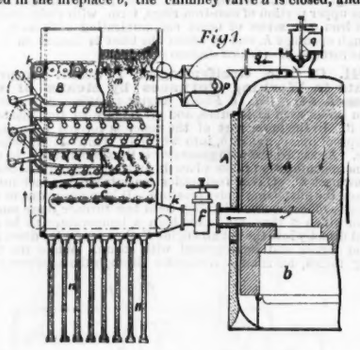
15,438. G. Watson, Glasgow, N.B. Method of Obtaining Baths of Chloride of Antimony for Use in Dyeing and Calico Printing. [6*d*.] December 16, 1885.—According to this invention solutions of the chlorides of sodium, potassium, or magnesium, or of mixtures of any two or all of them, are used as media for diluting chloride of antimony, which may, or may not, contain free hydrochloric acid. (*Sealed December* 17, 1886).

15,716. Dr. C. Rudolph, Hochst, and Dr. O. Gurke, Elberfeld, Germany. Manufacture of Colouring Matters. [6*d*.] December 21, 1885.—This invention relates to the production of naphthalene-trisulphonic and naphthol-disulphonic acids and their salts, and to the preparation of azo-colouring matters by causing the diazo combinations of aromatic amines to act upon an alkaline solution of the naphthol-disulphonic acid. (*Sealed December* 17, 1886).

15,743. H. Standen, Harlesden, Middlesex. The Manufacture of Glass for Sanitary and other Purposes. [6*d*.] December 22, 1885.—The glass is made from silicon, lime, salts, oxides, and carbonates, taken in varying proportions. (*Sealed January* 11, 1887).

15,809. T. R. Shillito, London. (*Dr. R. Baur, Stuttgart, Germany.*) **An Improved Process for the Treatment of Flax, Hemp, China-Grass, and similar Vegetable Fibrous Materials, in order to Obtain Fibres.** [6*d*.] December 23, 1885.—Vegetable fibrous materials are treated with hot dilute sulphuric acid which thoroughly opens out and breaks up the substance which incrustates or incloses the fibre. (*Sealed December* 31, 1886).

15,897. M. P. W. Boulton, Tew Park, Oxford, B. E. R. Newlands and E. Perrett, London. A Process for Revivifying Spent Charcoal. [8*d*. 3 *Figs*.] December 24, 1885.—The revivifying vessel B contains several tiers of shelves C, each shelf consisting of numerous sections *h* each capable of being turned on pivots by means of levers *i* actuated by a travelling chain *k*, which has on it at intervals rollers that engage and release the levers *i* in succession. The hopper *l* at the top of the vessel has several revolving feed wheels *m*. At the bottom of the vessel are tubes *n* for cooling the revivified charcoal. The loosely packed firebricks *a* in the heater A having been heated by a fire kindled in the fireplace *b*, the chimney valve *d* is closed, and the



valves *q* and *f* are opened, and the fan *p* and chain *k* are set in motion. Air is thus drawn from the vessel B and circulated through the heater A. The heated air flows by the passage *e* under and over the successive shelves C, thus coming in direct contact with the charcoal. The spent charcoal is fed from the hopper by the rotation of the wheels *m*, and by the tipping of the sections *h* drops from shelf to shelf, thus coming into contact with air of higher temperature as it descends, until it is finally discharged into the coolers *n*. When the heat in the heater is exhausted, the connections between the heater and the vessel B are closed, and the heater is then reheated. (*Sealed December* 24, 1886).

15,947. F. Candy, London. Improvements in the Preparation of Fuller's Earth for Use in Manufactures. [6*d*.] December 28, 1885.—The improvements consist in thoroughly intermixing the several constituents of fuller's earth without previously adding water to the earth to such an extent as to render it necessary to allow any of the added water to flow away. (*Accepted October* 29, 1886).

15,948. F Candy, London. Improvements in the Treatment and Utilisation of a Certain Kind of Clay. [6*d*.] December 28, 1885.—The improvements relate to the production of deodorising and filtering materials, and of pigments, electric carbons, and marking materials, from carbonaceous clay by carbonising or calcining the same. (*Sealed January* 4, 1887).

15,953. A. Hieronimus, Strasburg, Germany. Making Size or Dressing Material for Textile Fabrics, and to be Used in Polishing Twine, &c. [6*d*.] December 29, 1885.—A paste made by boiling in water meal that has been used with eggs in tawing skins, is combined with a liquid obtained by boiling skin scraps or other suitable animal matters in water. (*Sealed January* 4, 1887).

38. B. F. Cresson, Philadelphia, Penn., U.S.A. Dyeing and Printing Aniline Black, and Solutions Used therefor. [6*d*.] January 1, 1886.—The solutions are composed of chlorate of potash, sal-ammoniac, sulphate of copper, nitrate of iron, tragacanth gum, aniline oil, muriatic acid, and tartaric acid, dissolved in water. (*Sealed December* 17, 1886).

46. E. W. Parnell, Chester, and J. Simpson, Liverpool. Improvements in the Production of Pure Carbonic Acid Gas. [8*d*. 1 *Fig*.] January 2, 1886.—The improvements consist in the repeated use of carbonate of ammonia for the alternate absorption and liberation of the carbonic acid produced from lime-kiln gas or from the products of combustion, the absorption being conducted at a low temperature, and the subsequent liberation at a higher temperature. (*Sealed December* 21, 1886).

510. A. Brunstein, Moscow, Russia. Improved Method and Apparatus for Obtaining Alizarin Oil from Oleaginous Seeds. [11*d*. 12 *Figs*.] January 12, 1886.—According to this invention alizarine oil may be obtained directly from oleaginous seeds by passing the seeds through a roller mill into which concentrated sulphuric acid is at the same time made to flow, after which the solid and liquid substances are separated from each other by subsidence and decantation. (*Sealed January* 28, 1887).

564. O. Chemin, Paris. Treatment of Animal Fibres or Mixed Fabrics to Remove Vegetable Matters therefrom. [6*d*.] January 13, 1886.—This invention relates to the use of hydrofluoric acid either in a gaseous or in a liquid form for the elimination of the vegetable matters. (*Sealed January* 4, 1887).

596. C. Fahlberg, New York, and A. List, Leipzig, Germany. New Compounds of Organic Alkaloids and Saccharine and Method of Producing the Same. [4*d*.] January 14, 1886.—The object of this invention is to render less disagreeable the taste of various organic alkaloids used as medicines, such as quinine, &c. Neutral or acid compounds of organic alkaloids with saccharine are produced by dissolving the alkaloid in water or alcohol, and adding to the solution saccharine (anhydro-orthosulphamine-benzoic acid) in such quantity as either to neutralise the solution or to render it acid, and separating out the salt formed by the combination of the alkaloid with the saccharine. (*Sealed December* 21, 1886).

3116. M. F. Heddle, St. Andrews, Fife, D. C. Glen, and D. Stewart, Glasgow, N.B. Filtering and Decolorising Sugar Syrups and other Liquids, and Preparing a Material therefor. [6*d*.] March 5, 1886.—The improvements consist in the use of a material of the kind known as diatomite, or desmid earth, or white peat, kieselguhr or bergmehl, and prepared by being carbonised. (*Sealed December* 10, 1886).

3138. G. T. Lewis, Philadelphia, Penn., U.S.A. Improvements in the Smelting of Tin Ore and Recovering Tin from Tinned Sheet-Iron Scraps. [8*d*. 1 *Fig*.] March 5, 1886.—The tin scraps are heated in a cupola furnace with a double set of tuyeres, and the escaping tin fumes are condensed in strainers of textile fabric. (*Sealed December* 21, 1886).

9867. J. T. King, Liverpool. (*C. Vose, Brooklyn, U.S.A.*) **Extracting Paraffin from Petroleum Distillate.** [11*d*. 7 *Figs*.] July 31, 1886.—According to this invention the distillate is frozen in a freezing box, whence the frozen cakes of distillate are discharged directly into a trough in which is a rotating cutter for cutting up the mass into pieces. The frozen particles of the distillate are then subjected to pressure for the extraction of the petroleum which is mechanically associated with the paraffin. (*Sealed November* 30, 1886).

10,009. H. H. Lake, London. (*Count Rudolphe de Montgelas, Philadelphia, U.S.A.*) **Apparatus for the Manufacture of Chlorine Gas.** [6*d*. 1 *Fig*.] August 4, 1886.—The improved apparatus consists of an earthenware vessel provided with a perforated tray. The binoxide of manganese in a dry state is placed upon the perforated tray. The hydrochloric acid is supplied through a tube, and fills the space below the tray, and rises up through the perforations and so meets the binoxide. The evolved chlorine collects in the upper part of the vessel whence it is drawn off by a pipe. (*Sealed November* 26, 1886).

10,280. J. Y. Johnson, London. (*Dr. F. von Heyden, Dresden, Germany.*) **A Process for the Manufacture of Oxychinoline Carbonates.** [4*d*.] August 11, 1886.—The oxychinoline carbonates are obtained from oxychinoline alkalies and earthy alkalies by treatment with carbonic acid under pressure and at an elevated temperature. (*Sealed December* 7, 1886).

10,605. W. R. Lake, London. (*Count Rudolphe de Montgelas, Philadelphia, U.S.A.*) **An Improved Process of Extracting Aluminium from Chlorides of the Same, and of Aluminium and Sodium.** [4*d*.] August 18, 1886.—Equal quantities of chloride of aluminium and chloride of sodium are melted together. After melting, zinc is added in a granulated form, and heat is again applied to reduce the whole to a thin fluid mass. The zinc aluminium alloy is poured off, and to it is added a quantity of double chloride of aluminium and sodium. The whole is then re-fused with the addition of a small amount of magnesium. Finally the alloy is melted with a suitable flux, such as muriate of potassium with chloride of sodium. The result is the removal of the zinc and the production of pure aluminium in the crucible. (*Sealed November* 26, 1886).

10,606. W. R. Lake, London. (*Count Rudolphe de Montgelas, Philadelphia, U.S.A.*) **Extracting Aluminium from its Chlorides.** [4*d*.] August 18, 1886.—Chloride of aluminium, lead oxide, chloride of sodium, and charcoal, are intimately mixed, and fused in a crucible. The compound, after cooling, is powdered, and is melted again with the addition of metallic magnesium, and a flux, such as muriate of potassium. After cooling the mass is pulverised, and is fused again with an additional quantity of muriate of potash with a trace of nitrate of potash. The fused compound is then poured into water, when the lead present being heavier sinks to the bottom of the vessel, and the aluminium is found above in the form of small globules. (*Sealed November* 26, 1886).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford street, Strand.

THE RHINE.—In consequence of difficulties attending the navigation of the Rhine from Strasburg to Mannheim, a canal has been projected from Strasburg to Ludwigshafen, opposite Mannheim. The legislature of Alsace and Lorraine has voted a credit to assist this project.

NEW INDUSTRIAL UNDERTAKING ON THE FAROE ISLANDS.—Miss Von Post has recently sold her rights in the Suderöe coal mines to a French concern, bearing the name of "Société Générale Minière et Metallurgique des Iles de Faröe." The company has also bought other property on the same island. The capital is 4,000,000f., and Miss Von Post is said to have taken shares to the extent of 900,000f. It is the intention of the new company to work the coal and copper mines, other industries, such as fishing, being also contemplated.

TELEPHONY IN SCOTLAND.

(*Continued from page* 98.)

SINCLAIR'S automatic switch board, which we illustrate below, is a new instrument for connecting together subscribers of telephone exchanges without the intervention of an attendant to couple the one line to the other. It is the invention of Mr. D. Sinclair, engineer to the National Telephone Company, and has been in operation for some time in one of the company's branch exchanges in Glasgow. The instrument is designed to perform the duties which are usually undertaken by an attendant, those of switching any subscriber on the branch exchange, in which it is placed into connection, with any other subscriber on the same instrument, or with any other subscriber on the system; and it is particularly applicable in outlying districts, where the number of subscribers is not sufficiently large to pay for the expense of an ordinary exchange, and for Sunday and night service in larger branch exchanges.

Fig. 16.

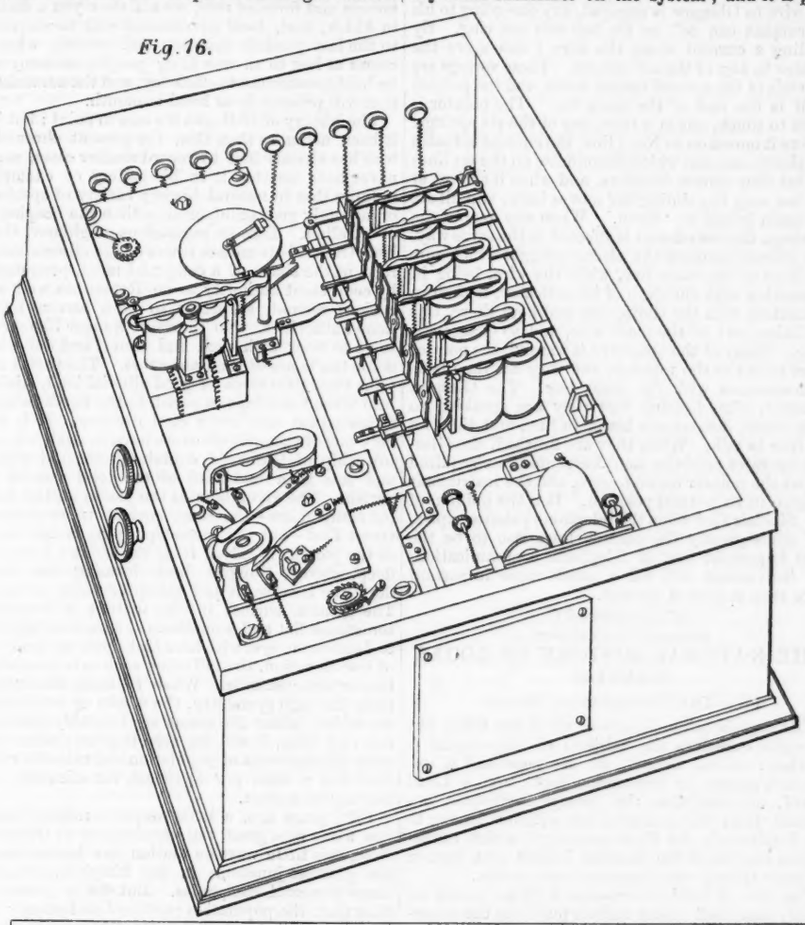
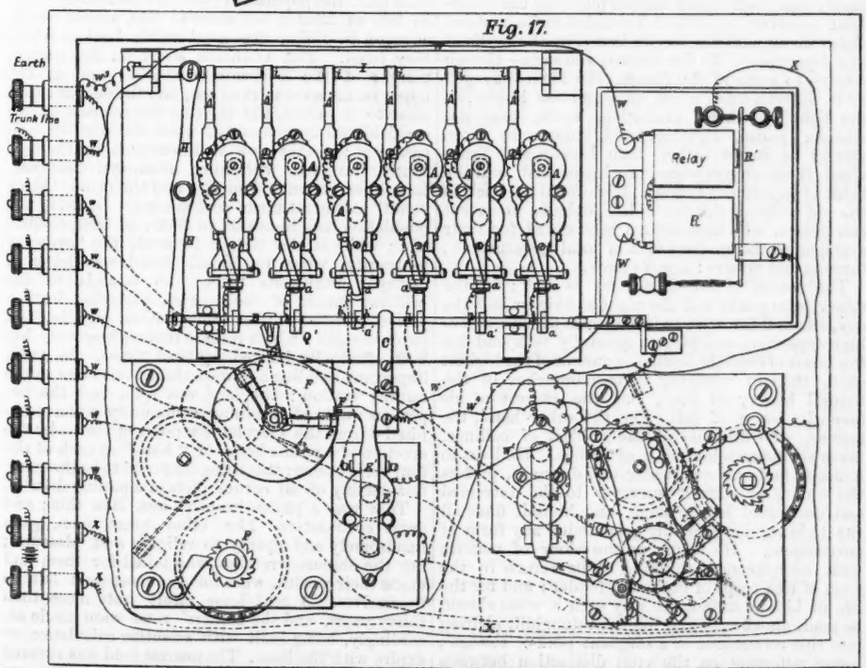


Fig. 17.



The principle on which the instrument under notice operates may be stated in the following way: A step-by-step sender is employed at a central exchange to transmit electric currents to the automatic instrument, which is placed in the branch exchange, and each impulse passes through the coils of an electro-magnet or relay, which acts on the escapement of a clockwork, and thereby intermittently turns a spindle on which a pointer is carried. In an instrument arranged to work six subscribers' lines—such an instrument as we illustrate—th pointer has seven stops in the revolution, and seven impulses from the central exchange are required to send the pointer once round—a stop being made at each of the seven resting points. At each of these resting points there is fitted a spring, or terminal, which is connected to a subscriber's line, and the pointer on the spindle makes contact with the terminal opposite which it stops, as it is sent round by the impulses from the central exchange. The pointer is electrically connected with the central exchange, and it is obvious that when it is brought into contact with the terminal spring connected to any of the subscribers' wires, the circuit over that wire to the exchange is closed, and the subscriber may be rung up or spoken to from the exchange.

With this explanation, the construction of the instrument and the mode of working it may be more readily followed by reference to the accompanying illustrations, which show the instrument by itself, both in perspective and in plan.

The wires from each subscriber's instrument are led to separate indicators A A, which are fitted in a row, in front of a reciprocating notched bar, shown at B B. On the drops a a of the indicators there are fitted projecting arms which are marked a^1 a^1, and which, in the normal position of rest of the reciprocating bar, extend over inclined notches b^1 b^1, formed in the bar. When any subscriber rings up the exchange, the projecting arm a^1, on the corresponding indicator drop a, falls into the notch b, and makes contact with the notched bar B B, which is electrically connected with the central exchange. In this way the exchange operator is called up. The connection between the central exchange and the reciprocating bar B B, is made through (1) the trunk wire W, (2) the coils of a relay electro-magnet R, (3) the wire W^1 W^1, and (4) the terminal and spring C, bearing on the bar B B. At the same time the current passes through the notched bar B B, by means of a spring D, and the wire W^2 to the coils of an electro-magnet marked E (similar to one of the subscribers' indicators), the armature E^1 of which is fitted with an escapement device F^1 arranged to set free the clockwork F, which acts through a lever G on the notched bar, and moves it in one direction to such an extent that the arm a^1 on the indicator-drop is pressed into the inclined notch to remain in electrical contact with the bar, while the other notches are no longer directly under the arms on the remaining subscribers' drops. But these drops now rest on or lie over small pieces of vulcanite, so that these subscribers cannot for the time being ring up the exchange or each other.

The notched reciprocating bar, already spoken of, is also connected by means of the lever H, to a rod i i, on the opposite side of the indicators. This rod being connected to "earth" by the wire marked W^3, or serving as an "earth" wire for the subscribers' lines through the indicators, the movement of the notched bar traverses this "earth" rod to a slight extent, and brings under the contact springs A^1 of each of the indicators a vulcanite on the rod, whereby the "earth" connection is cut off; and as the subscribers are unable to ring their call bells they understand that the trunk wire is engaged.

So far, our descriptive remarks have had reference to the fact of a branch subscriber ringing up the exchange for any requirement, either of the exchange itself or any fellow subscriber; and now we proceed to speak of the mode in which connection is made between the central exchange and each subscriber on the branch exchange. This is done through a finger or pointer, marked j, on a spindle J coming into contact with one of a series of springs K K, to which the subscribers are connected. The spindle J is rotated to such an extent as to bring the finger or pointer j into contact with the spring K, connected to any one of the subscribers on the exchange, by means of clockwork M and an escapement M^1, operated directly by an electro-magnet M^2, which is brought into action by the relay R when a current is sent

along the main wire. The pointer is also employed to make a momentary contact between a spring L and a stud L^1, thereby closing the circuit X through a local battery, and through the electro-magnet E, which acts on the escapement device F^1, controlling the action of the clockwork F employed for actuating the notched reciprocating bar B B, as formerly mentioned. When this electro-magnet is thus momentarily brought into action, the escapement F^1 is attracted, and releases the clockwork F, so that it again traverses the notched bar, but this time in the reverse direction, by which means the arm on the subscriber's indicator-drop is raised out of the inclined notch, and all the notches are again immediately brought under the projecting arms of the indicator-drops. This motion of the bar B B is accompanied by a like motion of the rod I I, which, on being traversed, brings every subscriber's line in connection with the "earth" wire, so that any subscriber may ring, and the same cycle of operations be repeated.

The return movement of the notched bar, from the position which it assumes after a subscriber calls up the exchange, is effected in the way already mentioned. The operator at the central exchange sends as many currents as may be requisite to bring the pointer round to the position in which it presses together or makes contact between the spring L and the stud L^1, which closes the local battery circuit X through the coils of the electro-magnet E, and thus actuates the escapement which releases the clockwork.

In order to effect communication between the central exchange attendants and the subscribers, the following mode of operating is resorted to. The exchange operator sends a battery current through the trunk wire W through the coils of the electro-magnet or relay R, to the reciprocating bar B B, through the electro-magnet E, and thence to "earth." In its passage the current closes the armature R^1, or the relay, and then closes the local battery circuit X, and effects, by means of the clockwork M, one forward step of the pointer, from zero to the first spring K, connected to the subscriber's wire *w*. At the same time, by acting on the armature of the electro-magnet E, the clockwork effects a movement of the reciprocating bar, which cuts off the connection from the subscribers to "earth," and also the electro-magnet acting on the clockwork. The succeeding current, sent by the exchange operator, passing through the relay R, closes the local circuit as before, actuating the spindle, and finding its "earth" through the subscribers' spring K and wire *w*, with which the pointer is in contact. Each succeeding current acts in like manner until the pointer rests on the spring of the subscriber wanted. The exchange operator is then in direct communication with the subscriber. When the conversation is at an end the operator continues to send currents until the pointer reaches zero. In making its last step to zero the pointer presses the spring to make contact, and closes the local battery circuit through the electro-magnet acting on the clockwork F, and thereby moves the bar B B back to its normal position, when the subscriber will be connected to "earth," and the exchange trunk line will find its "earth" through the relay R, the bar B B, the spring D, and the electro-magnet E.

The wire W^4, from the spring C to spring C^1, which is requisite to give the connection with the spring D, is disconnected from the reciprocating bar B B, and the connection thus given depends upon the position occupied by the pointer *j*. It should be noted that when the pointer is brought round so as to make connection between the exchange and the subscriber wanted, a magneto current is used to ring up the subscriber, and this intermittent current does not actuate the relay.

This instrument was shown at the stand of the National Telephone Company in the Edinburgh Exhibition, where it excited much attention from many of the visitors interested in the progress of telephony. By way of giving some indication of the usefulness and mode of working the automatic switch-board under notice, we may give a few remarks made in reference to it by the inventor before the Philosophical Society of Glasgow. "Supposing," he said, "there are six places in Renfrew that wish to join our exchange department in Glasgow. I run one wire to Renfrew and attach it to the instrument which can, of course, be placed in any position. It does not require an office. I then run a wire from the six different subscribers to the instrument. The operator in Glasgow has power to ring any one of them and speak without interfering with the others, and power to join any two of the six so that they can talk. Any of the six can ring the Glasgow Exchange when the single wire is not otherwise engaged. There is nothing required in the subscriber's office but the ordinary telephone and bell. When the wire to Glasgow is engaged, any one going to his instrument can tell, as his bell will not ring. By sending a current along the wire I can move the pointer to any of the six springs. These springs are the ends of the several branch wires, and the pointer itself is the end of the main line. The pointer is made to touch, one at a time, any of the six springs. Before it moves on to No. 1 line, the current actuates the electro-magnet which disconnects all the six lines so that they cannot interfere, and when it arrives at the last step the sliding bar moves back, and all six are again joined to 'earth.' When any one of the six rings, the instrument is affected in the same way. The current actuates the electro-magnet which cuts the lines of the other five, while the wire, being in connection with the drop of its indicator, is then in connection with the sliding bar and kept there, this bar being part of the main wire, and so Glasgow is rung. If any of the other five is wanted, the pointer is set round to the number, and they are then both in connection with the main line. The Glasgow operator, after hearing that they are speaking to each other, disconnects his main line, and the two are free to talk. When they are finished, the Glasgow operator sends as many currents as are required to put the pointer round to zero, and the instrument is again in its normal position." It is the opinion of Mr. Sinclair that when the telephone patents expire, and consequently the outside lines rise to be the most important part of telephone communication, the instrument will fill a much more important place than it does at present.

(To be continued.)

THE NATURAL HISTORY OF LOCAL BOARDS.

IV.—The Experimental Board.

The *experimentum in corpore vile* is one thing, but to make ourselves the subjects of experiment is another; unless, indeed, we are possessed of uncommon genius, or uncommon luck; and a Local Board, no more than the average individual, can deviate from the common rut without having to pay handsomely for their temerity; which nevertheless may be of the greatest benefit as a beacon to other Boards which aspire to originality.

The love of local government is by no means so deeply ingrained in the British public as the superficial observer might be led to think as he contemplates the annual blue-books issued by the heads of this department. To the masses, and even—though rarely—to some of the classes, the ideas conveyed by it all turn upon more rates and less liberty, in the light of which, sanitation, roads, markets, schools, police, lighting, and order, are often viewed as curses rather than blessings. True, when these conveniences are introduced, and the habit of enjoyment formed, few would go back to the old order of things; unless, indeed, we except two classes, who have always been noted for their aversion to the modern idea of local government; farmers and miners: *experto crede*.

The reason of this is not far to seek; for the miner, who works half the night and sleeps half the day, has in this matter an intelligence which matches his complexion, and prefers generally to spend his few hours of daylight less in the pursuit of the highest good, than in studying certain branches of the natural history of dogs, and the interest of his favourite house of call. On the other hand, the farmer, who fills one of the noblest of callings, takes an independent view of things. He lives to himself, finds his own water and drainage, prefers the county or district surveyor to the untrained and underpaid local drudge, and himself finds all the lighting he generally gets under any form of government. He snuffs up the odour of manure with complacency, thinking of its return in the form of rich crops of grain and fodder; and for the life of him he cannot see why such a noise should be made about a fat and innocent dunghill, melting into ripe rottenness, or a stagnant pool of sewage; never reflecting on the vital distinction between the manure of which you are the master, and the manure which is master of you; although few are so quick to perceive that even the pure water so fertilising where it percolates freely through a porous well-drained soil, poisons the herbage when it stagnates in a morass. Therefore, although the law obliges him to pay no more than one-fourth of the rates levied for most of the purposes of local government, he views even this as an odious tax upon a not very thriving industry.

If, then, you will show us a growing district where miners and farmers rule, we will show you a district in which, first, local government will be staved off to the last possible minute; and second, when it comes at last to an unwilling people, economy will be held paramount to efficiency, and the administration will proceed from hand to mouth.

The history of Oldhards is a case in point; but had it been no more than this, the present chronicler, who has already had to record similar cases, would never have inserted it in his gallery of examples, holding that in natural history variety of species is of infinitely greater importance than the heaping up of parallels. Like its pugnacious neighbour, Great End, Oldhards possesses traces of the all-conquering race in the shape of a camp and moat, pronounced by competent authority to be Roman, as well as a curious mound, suspected to be a barrow by the same authorities, who therefore hunger like ghouls to go to work with pick and shovel and delve into it for the bones of their ancestors. The parish contains over 4000 acres of good alluvial land, divided into three townships, a parish in the north being an ecclesiastical and not a civil division. It is with only one of these divisions we have to deal, viz., the township of Oldhards, containing the old village, and less than one-third of the total area of the parish. The river bounds the parish on the north for many miles—the same ancient trout stream of Great End—but our township, lying in the centre of the parish, is cut off from its banks; a narrow, deep, clayey, sluggish beck forming the boundary line between it and the intervening township. The general surface of the district is irregular; sometimes flat and sometimes sloping so slightly as to deceive the eye, with here and there an eminence of low elevation, the fall being such as to necessitate two or three outfalls. When to these aberrations from drainage symmetry, the effects of coal mining are added, where the seams are tolerably thick and not very deep, it will be seen that no matter what were the resources of population and rateable value, here was a case, *par excellence*, for scientific engineering treatment.

Fifty years ago, a little wayside railway station was made by a great railway company at Oldhards. Now, this little wayside station has become one of the greatest junctions in the kingdom, owned by three powerful companies. But for a generation after that, the population remained stationary; and so late as 1860 it fell short of 600, almost wholly engaged in tilling the good arable land on which they lived. But Oldhards stood on the eastern margin of the Yorkshire coalfield; and as the upper seams were worked out, and the deeper seams came to be valued, the shifting boundaries of the coalfield swiftly encroached upon the district, and passed it; so that now it lies almost in the very centre, invested with long chimneys, headgear, tram-lines, steam and smoke, and the usual "black vomit" attendant upon coal mining. In 1871, the population had increased to 3500; in 1881, to 6000 odd; while in the riotous interval, the heyday of prosperity, when the Local Board was lying in embryo, enthusiasts placed no bounds to the brilliant future of the district, picturing forth a perfect paradise of pits, colliers' rows, pigsties, and public-houses; which roseate future, however, has been effectually blasted by hard times. In 1865, important building lots were staked out close to the railway station; the land was sold, and the imperious wants of a mining community were recognised—from the speculator's point of view—by the erection of a public-house or "hotel" at each of the four corner plots; that being supposed to be the manifest destiny of all corner plots in a mining district.

That was a philanthropical age, like this; and great coalmasters, like other great men, gave handsomely and openly to religion and pleasure; but the obscure wretches who toiled for them and made their wealth, were for the most part left to themselves. A coal lease rarely lasts more than thirty years, and the colliers' rows were made accordingly, being built with scientific calculation to expire with the lease. The nearest field was covered with back-to-back shells, tenanted before they were dry; with kitchens like pantries, one bedroom, partitions of brick *on edge*, jerry fireplaces, ovens, doors and fastenings; sinkless and drainless, and with a rain-water butt for all purposes. A few

ashes were carted on to the space before the doors, and called a road; on the opposite side of which, and sometimes in the middle, pigsties and privies formed a pleasing feature in the landscape. We once heard a mining engineer speak of an immense row of colliers' cottages as a "little hell," where almost every crime was committed to which a name can be given; but this was no concern of the master. There are many exceptions, but the rule is: let poor folk welter along, their blood is on their own heads; all the owners have to do is to see that these kennels are well filled, and pay a regular 8 or 10 per cent. "The landlords don't care a rap if they get your five bob on a Monday morning." Oldhards crowned its prosperity with batches of these rows, which were, indeed, fit objects for a "devil's walk."

As might be expected, therefore, the great coal-owners held aloof from local government in Oldhards; and the masses, whose instincts we now know, on high authority, are unerring, were left to their own devices. The Local Board had no auspicious birth. The guardians had—with half a heart—tried to cope with its sanitary difficulties, but gave it up as a bad job, washing their hands of them. Then an effort was made to get the whole parish to adopt the Act; but at a meeting held in 1871, the parish declined any such thing. After this, the township itself declined, asking the guardians to do for them what they saw fit; upon which, as sewage complications thickened, and lawsuits impended, the guardians, feeling beyond their depth, and declining to call another meeting to continue the game of "shuttlefeather," as one of them termed it, applied to the Local Government Board for an inspector to be sent down.

It was high time, for, as a local paper said, "The air they breathed was big with death." A town's meeting was called to discuss the situation, and the humours of a divided audience were exhibited. Those who suffered made long speeches for a Board; those who did not made short ones against it. "No deep drainage," said one simple orator, "for it is awful to make the inhabitants pay some *hundreds* of pounds for such work." Another would put down a main sewer without a Board. "Where's your outlet?" retorted a third. The answer was ready. "I would sink a shaft. Put good cesspools down, cleanse the water, sink a shaft, and let it go down." The skin of mother earth suffers many outrages, and punishes the offenders by horrid forms of disease and death; but here was a man who proposed to sluice her bowels with sewage, and would willingly, to save a fourpenny rate, convert them into a universal cesspool for all the nations of the earth. But this heroic solution of the great sewage problem did not go down. A fourth thought that if every man drained his own doorstone, no Board would be required. Huge laughter was excited by an anonymous letter protesting "against 'sirvairs' that could not reed and right," and against farmers generally as "sirvairs." The situation was tersely summed up by the chairman, who said that the Local Government Board would compel them to have a Local Board, and therefore, with all their power and oratory, and all their reason, they could not prevent it; while all were agreed that in fighting against the inevitable evil—the dreaded Local Board—the two township guardians had "stuck" to their guns like a "good John Bull."

At another meeting it was bluntly declared that only the working classes wanted a Board, the gentlemen—the big guns—standing on one side. They were more hungry for dividends than sanitation; and at the present juncture could only ejaculate, as they saw the shadow of coming events, "Hast thou found me, O mine enemy?" Once more the *pros* and *cons* were discussed. "People dying of small-pox in houses environed by horrid stenches," said one. "Filth oozing through walls," said another. "Ay! but a Local Board 'll mak' our tenpenny highway rate into three shillings at least." Cellars were cited where candlelights turned a ghastly blue, and explosions were dreaded; also the nuisances inseparable from pigs, petties, and dogs. "Dogs is cleaner nor pigs," said a dog fancier. "Ay, but a pig's a very nice thing a few days afore Christmas. It's a good pictur'. Nicest pictur' in a house barrin' a woman" (cheers and laughter). The chairman had a difficulty in preventing riot. "One dog, one bone," said he with terse emphasis, when two or more furious speakers were up at once. "We are true water savers" said a humorous ratepayer, with capital irony; "where I live we have nothing to do but empty our slops into the ash-pit, and we drink the water over and over again." The upshot of all which was that the Board was to come, and the proud people of Drinkbilge—they belonged to the Drinkbilge Union—shown that they were not a "set of colliers."

The Local Government inquiry may be passed over, as well as the last audit of the old highway surveyor's muddled accounts, in which a mysterious item of expense could not be accounted for; incidents which present nothing new to add to a scientific knowledge of our theme; and the reader must now consider the Oldhards Local Board duly elected. The local governors were nine in number, elected out of the usual five-and-twenty who went to the poll. Four were farmers and two innkeepers, which latter our honest colliers are a little too apt to regard as their best friends.

The first official act of the Experimental Board was to advertise for a man to act as clerk and collector of rates for a population of 5000; and notwithstanding the prosperity of the times, they found two forlorn beings whose needs were so pressing, or whose misery was so great, as to induce them to apply for the double post at a stipend of 20*l.* per annum, finding 200*l.* security into the bargain. One of these was appointed: this was the first experiment.

At the second meeting they received a letter through the chairman from an engineer in the nearest market town, offering his services, in the matter of main drainage, at the cheapest possible rate, viz., 50*l.* for survey and plans, and 1*l.* a week for carrying out the works, which was thought so reasonable in price that the quality was not thought of, and he was straightway appointed to his arduous duties; the only thing remarkable about which is that the Board made no attempt to cheapen their man.

The Board had not got much further when their very existence was assailed, and pursuant to a complaint which had been preferred and proved by certain disappointed candidates, the Local Government Board declared that the election was null and void, inasmuch as members of the Board, by their becoming candidates, could not act as returning officers. But nothing was further from their intention than resigning. One member—of the school of Carlyle—thought the course of the opposition "base and devilish" (hear and laughter). "I am in, and mean to keep in. . . . Never mind how. . . . They may fiddle away until they are old men, and Oldhards will never elect them." So they stuck to office for a time, and appointed a treasurer at 40s. per annum, and a surveyor and nuisance inspector at 26s. weekly; at about which time a ratepayers' association was formed by their rivals to keep their extravagance in check. But notwithstanding this, the Board, having thought better of it, went again to the poll, and were again triumphantly elected, when they swiftly indorsed all their previous acts.

In no very long time a scheme of drainage was matured, or perhaps it may be more justly said, pre-matured, which proposed a gravitation outfall with treatment of sewage by intermittent filtration and irrigation combined. This was for a part only of the district—the central part; for which the outfall sewer was to be a brick culvert, 48 in. by 32 in., with tributary pipe sewers varying from 25 in. by 18 in. to 12 in. circular. This was looking a long way ahead, and scarcely accorded with the simple forecast that main drainage would cost *hundreds* of pounds. But experience teaches quickly in these things; and a local governor's ideas soon expand from tens to hundreds, and from hundreds to thousands. The other and minor parts of the district were to be accommodated by temporary outlets into running streams, owners permitting. After much delay, owing to the premature birth of the premature scheme, it was decided to apply to the Local Government Board for power to borrow 5000*l.* in order to carry it out; but owing to a common custom amongst those local Boards which have a prejudice against hackneyed engineers and legal clerks, the cart went before the horse, and the inquiry was made before a word was said about the acquisition of land for the treatment of sewage, when it was discovered that notices must be given for compulsory powers entailing long delay and a new inquiry; so that a whole year elapsed before the scheme was sanctioned.

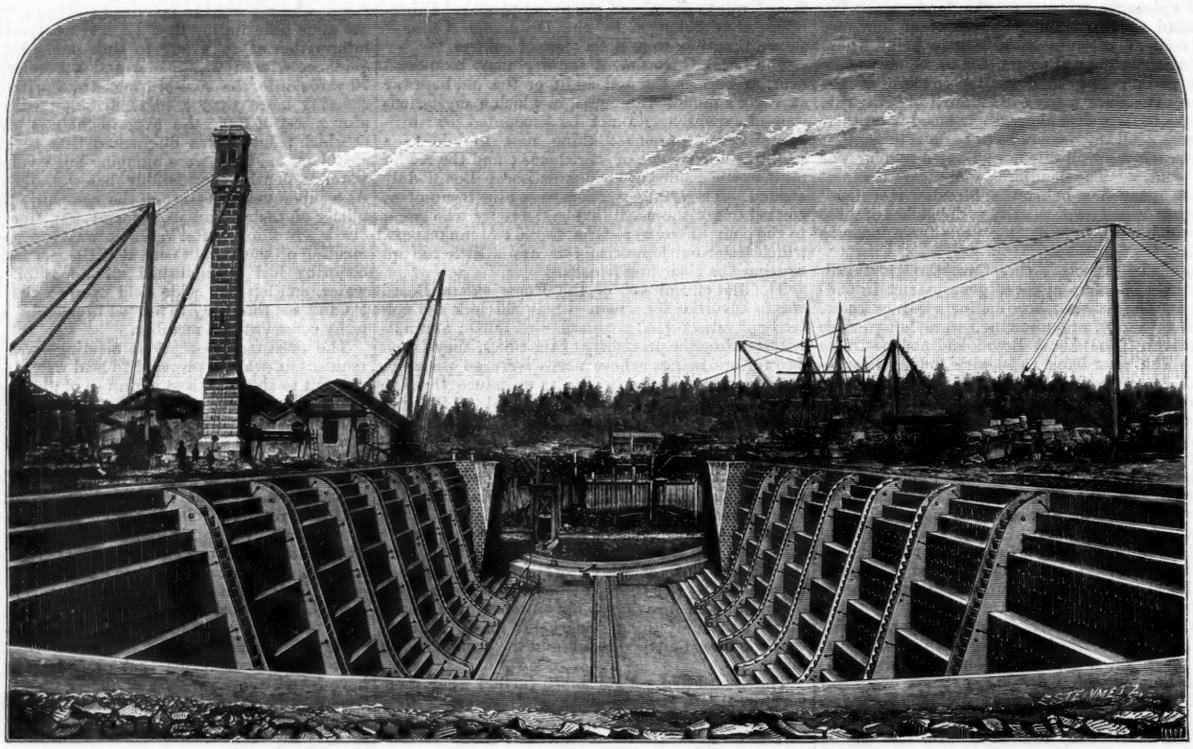
As may have been shrewdly guessed from the pleasantry of the "water-saver," hereinbefore cited, the district was at its wit's end for water. There was a gas and water company which supplied gas only, and let the water alone. Not altogether, however, for they had employed an engineer of experience who reported in favour of sinking a well, at the same time stating that he had no trustworthy information as to where to sink one. Under his guidance a trial was made, and a borehole sunk 70 yards into the coal-bearing strata without discovering more than a mere dribble; whereupon, after a cost of 150*l.*, the experiment was given up, at which point it was discovered that several coal shafts around them were pumping huge volumes of water at depths considerably below the borehole. At a subsequent meeting of the company, the simplicity of their blind experiment was freely criticised. Not long afterwards it was reported at a meeting of the Local Board that the gas and water company had relinquished all hopes of getting water, and left the wide field open to the Board. "Can't see their way to a good dividend," was the pithy comment of a member.

The usual motor—a public meeting—was put in requisition, when a proposal to lead water in barrels was put to the vote, and approved of; but the question rose, who was to provide the barrels? This was solved at the very next meeting of the Board, who generously ordered the purchase of a water-cart, at the same time decreeing a toll or charge of one penny for three buckets by the man by whom it was farmed. But the wheel of the cart soon ceased to rotate, for in less than two months the contractor threw up his job, finding it did not pay, from which a thrifty member argued that the people had enough water of their own, and did not want more. But the Board did not accept this ingenious solution of a very knotty problem, thinking the wish father to the thought, and they instructed their engineer to report, which he accordingly did.

It must be confessed that any engineer would have found it a hard task to build up a tight and feasible water scheme for Oldhards; and one who claimed experience had already failed, as we have seen. But experience, though prolific, is not always the mother of wisdom. The two square miles of the township stood on the lower side, geologically, of the magnesian limestone, and contained no stream or spring available or fit. Samples of water from the five brooks which flowed through it were analysed with superfluous caution, and rejected, as well they might. No gravitation scheme lay within reach of their slender financial resources, that being one of the privileges reserved for rich corporations. The river, as already found out by Great End, offered nothing better than a liquid which all the resources of science could not make other than clarified sewage. This manipulated compound they might, indeed, have purchased ready made from their not too fastidious neighbours of Drinkbilge; but not having acquired that habit which is second nature, their gorge heaved at it, and the bare idea was ejected from their minds with as much rapidity as Sancho Panza's stomach ejected the famous balsam of Fierabras. Even Drinkbilge confessed, under parliamentary pressure, that their water was not perfection; and had in view a great gravitation scheme from pure millstone grit sources. Accordingly the engineer, doubtful of the local resources, naturally took refuge in a temporary supply with permanent works. His proposal was to purchase 100,000 gallons per day from a colliery in the district which had more than enough of a tolerable substitute for the pure element. This volume was to be pumped by the colliery owner into a reservoir at 3d. per 1000 gallons. The scheme was adopted at the next meeting; and an estimate of 6500*l.*, with application for borrowing powers, was speedily dispatched to the Local Government Board, who, after many amendments and additions, sanctioned the proposal at the same time as the sewage scheme, stipulating repayment in thirty years, and recommending a loan by the Public Works Loan Commissioners at the easy rate of 3½ per cent.

Amongst other things, the roads were lighted after a deliberation of nearly two years; and a medical officer appointed at 15*l.* per annum; at which trifling rate they valued the scientific custody of the public health. But, to say the truth, most of these small medical appointments are only made in obedience to those perverse laws which so often break through that salutary motto "Each for himself, and devil take the hindmost." The stiles and footpaths also engaged attention, and much warmth revolved around them, as might be ex-

ESQUIMALT DOCK; BRITISH COLUMBIA.



pected in a farmers' board; for, as usual, a law just in its application to the rural districts for which it was framed, was thought by the masses to be equally just in an urban district. However, the farmers gained the day, and made the ratepayers pay for the repairs of that section of the Queen's highways.

The moment the Board received the sanction for the water scheme, it was discovered that another copious spring of colliery water was to be had both cheaper and nearer. But the die was cast, and the original scheme went forward. Taking time by the forelock and looking a long way ahead, the Board availed themselves of an exceptional drought; and laid a line of cast-iron mains across the river bed below a weir. This had nothing to do with the present project, but was to be part of a permanent supply in the near future to be bought in bulk from Drinkbilge when their projected gravitation scheme was completed, which, though it was promised with the utmost assurance within a couple of years by one or two orators from that place during the local government agitation, has not yet arrived after a fifteen years' waiting, these promising gentlemen having leaped over many obstacles, parliamentary and engineering. The pipes still slumber in their lowly and watery bed, waiting for work to do, having narrowly escaped destruction from floods, which so moved them uneasily to and fro that it was feared they would sooner or later land at the next ferry.

(To be continued.)

ESQUIMALT DOCK.

This work, which is at last approaching its completion, and of which we give a perspective view above, was commenced in 1875 by the Colonial (British Columbia) Government, subsidised by the Imperial Government to the extent of 50,000*l*. Messrs. Kinipple and Morris, of London, built the cofferdam, pumped out, excavated about two-thirds of the dock, made part of the wing walls, and laid part of the concrete flooring, the pumping machinery, &c., being sent out from London. The Colonial Government, having by this time had enough of it, let the work to Messrs. MacNamee, of Montreal, who did about 8000*l*. worth of work and then broke. The work then came to a standstill for some time until after the entrance of British Columbia into the Union, when, in 1884, it was turned over to the Dominion Government, who reimbursed British Columbia for the funds already expended—about 84,000*l*.

The Dominion Government let the work to Messrs. Larkin, Conolly, and Co., of Montreal, for about 75,000*l*., though it is probable that another 20,000*l*. will have to be added to this owing to some alterations made afterwards. It will be seen that so far this dock has been a somewhat expensive concern.

At present the dock itself is practically complete, the delay being caused by the caisson, which, being made by the Montreal Bridge Company (at a cost of 9200*l*.), is now being put together in the dock. Until this is finished, and tried in its place, the cofferdam—which can be seen in the picture—cannot, of course, be cleared away. It may reasonably be hoped, however, that the end of April will see the first ship high and dry in the dock.

The dimensions of the dock are, extreme length to inner end of caisson when in its usual place, 445 ft., but it is so arranged that the caissons can be floated out and moved to the extremity of the dock, which gives another 30 ft., thus allowing a ship of 475 ft. to be docked. The entrance width is 65 ft., while the rest tapers from 90 ft. on top to 40 ft. at the bottom of the steps. The depth from top to bottom is 36 ft. 6 in., and since the top is 7 ft. above high-water ordinary springs, it follows that a vessel drawing 29 ft. 6 in. can be docked at such times.

The pumps, which consist of two main plungers of 48 in. diameter, and two smaller ones of 30 in. diameter (the latter being the ordinary draining pumps), can pump out the dock at the high-water level in about three hours, but the discharges are at low-water level, and it is intended as a rule to let the tide do its 10 ft. of work when practicable.

The dock is well constructed theoretically, but as the earthwork all round the edge has fallen considerably during the wet season, it would appear that sufficient care has not been taken in the ramming below. Briefly speaking, the floor consists of 2 ft. of masonry laid on a thickness of 5 ft. 6 in. of concrete, the outside 9 in. of this concrete both above and below being mixed in the proportion of 5 gravel to 1 cement, while the inner portion is much coarser and is 7 to 1.

The earth was dug back to a distance of 18 ft., and the side masonry is backed up with about 8 ft. of concrete, the upper portion where it runs back being supported by strong buttresses at intervals, connected by arches. The fall of earth mentioned before is probably caused by the earth with which these arches are filled not being properly rammed home. It is understood that H.M.S. Cormorant, now senior officer's ship at Esquimalt, will have the honour of first entering the dock.

THE INSTITUTION OF MECHANICAL ENGINEERS.

In our last issue we gave an account of the first part of the proceedings at the annual meeting of the Institution of Mechanical Engineers, held on the evenings of the 3rd and 4th inst., dealing with the discussion on the late Mr. Wyllie's paper on "Triple-Expansion Marine Engines" and M. Berrier-Fontaine's paper on a "Portable Hydraulic Drill." We now propose giving a brief abstract of the discussions on the two remaining papers read at the meeting.

Copper Mining in the Lake Superior District.

The first of these was Mr. Edgar P. Rathbone's contribution on "Copper Mining in the Lake Superior District," which was read by the secretary, and the publication of which, *in extenso*, we commence on another page. After the reading was concluded Mr. Rathbone added a few words, calling attention to the fact that the data given in his paper were intended especially to emphasise the fact that stamp mining pays better than mass mining. He had placed on the table specimens of the products of Lake Superior district mines, consisting of a mass of copper representing such as would be got out in the manner he had described, but of course not of the large dimensions referred to. There were also specimens of cores got out with the diamond drill, plates of native copper, some stone hammers originally used by the Indians in their primitive metallurgical operations, and many other objects of interest which the author explained at some length.

Mr. Bache, the secretary, next read a letter from Dr. Lee Foster, who asked for further statistics as to the production of the mines, and referred to the figures given in the paper. He asked if the Leavitt stamp had not superseded the Ball stamp, which the author had described and illustrated in his paper as being the one generally used.

In reply to this question Mr. Rathbone explained that the Leavitt stamp was really a Ball stamp with the steam cylinder compounded, the high and low-pressure cylinders being placed tandemwise. This

ROUGERIE'S ANÉMOGÈNE.

(*For Description, see next Page.*)

Fig. 1.

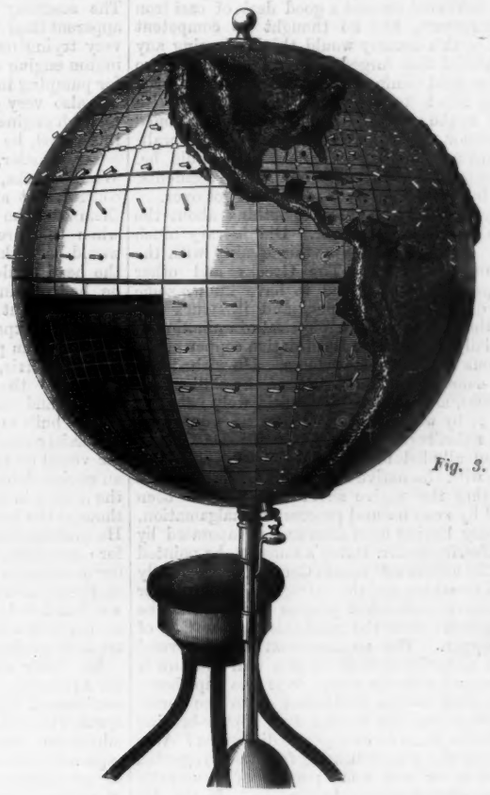
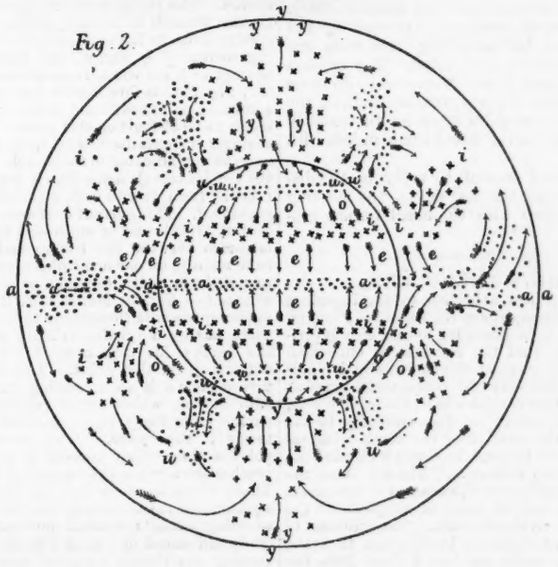


Fig. 3.

Fig. 2.



had been found a great improvement, but so far as the stamping parts themselves were concerned the arrangement remained the same.

Mr. Davey said that the fact of mass mining not paying so well as stamping might be taken as another example of the benefits conferred on industry by the skill of mechanical engineers. Ore containing no more than 0.75 per cent. of copper could be successfully treated by means of the stamp, while large masses of copper did not repay for the great trouble and expense of raising them. Seeing how successfully the Canadian operations had been, he would suggest that the application of similar methods to the large accumulations of refuse matter in Cornwall would lead to profitable results.

Mr. Bauermann spoke at considerable length on the subject, treating it from a metallurgical, geological, mechanical, and economic point of view. He also included a brief historical sketch of the Lake Superior copper mines, extending back to its commencement in 1845. Twenty-two years ago he had visited the district, when both the Calumet and Hecla mines were just square holes full of water. He traced on the map shown by the author where the earliest work was done, and produced from his pocket a sample of the first material got out. He did not agree with what the author had said as to great masses and fissure veins, enlarging on the subject. Mass mining was never unprofitable if enough of it could be obtained. The largest mass secured was got from the Central Mine, and weighed 800 tons. This was in 1866, and the solid copper was 4 ft. 6 in. thick. As to the Ball stamp, the great feature in it was that it took everything that was fed into it. It could never be known what was coming next. There might be a run of a lot of rock, and then some pieces of copper might follow which would take any amount of pounding, and the Ball stamp treated it all alike. The dressing machinery was improved greatly since he had first seen it, but it still bore unmistakable evidence of its Cornish origin, and it must be remembered that the Lake Superior copper district was originally a Cornish settlement. A question was here asked as to the manner in which the large mass of copper referred to by the speaker was got out, in reply to which Mr. Bauermann gave an interesting description of the methods adopted, illustrating them by diagrams on the black-board. Roughly, the mode of operation was to blast away all round the mass until it became detached. Then cutting by hand was resorted to, and here the great difficulty was to temper the chisels. If it were absolutely all copper there would be no difficulty, but pieces of quartz would occur, and these would naturally make trouble. When the mass had been got to a proper condition the chain from the winding engine would be attached, and by much manœuvring the piece would at last be coaxed to the surface. As to the silver which occurred, it had at one time been thought to be very pure, but the speaker had found it contained quicksilver in very minute quantities. The Lake Superior copper was no doubt the purest in the world, and was at one time thought to be absolutely pure, but it was now known to contain arsenic in quantities sufficient to be traced.

Mr. Sopwith called attention to the gigantic scale on which mining operations were carried on in America compared to those of this country, and instanced the Ball stamp, which has no compeer in the United Kingdom, as an example. Mr. Seymour also spoke to the same effect.

Mr. Appleby, speaking on the subject of stamps, said they were not largely used elsewhere in the form shown. He had watched the Ball stamp and similar types at work, and had concluded that the material was not able to get away fast enough.

That was a point that wanted attention, for though the machine would undoubtedly crush enormous quantities of material, it was necessary to be able to dispose of it as treated. For this reason he would prefer a greater number of smaller stamps. The drawing exhibited showed a good deal of cast iron in the structure, but he thought no competent engineer in this country would think of using any other material than forged steel. The speaker also referred to gold mining in Victoria, where material returning 2 dwt. to the ton was treated. With reference to the rotating table or buddle mentioned by the author, a drawing being shown on the wall, he thought it was as near perfect as it could be. The great point was that the liability of accidents, through being improperly worked, was got over.

Dr. Ryan wished to know something about the hardness of the native copper. Did it vary much and how did it compare in this quality with the copper of commerce? The Greeks and other ancient peoples are supposed to have known some method of hardening copper, and it struck the speaker that a chemical or physical examination of any specially hard specimens of native copper might throw some light on this problem. He wished also to know something of the life of the chilled iron stamp-shoes, and whether they ultimately failed by fracture or by wear. If by fracture he would suggest the substitution of forged steel. Dr. Bauermann had alluded to the presence of a trace of mercury with the native silver. He would like to suggest that the native silver might have been extracted by some natural process of amalgamation, the mercury having been afterwards evaporated by heat. Referring to Mr. Davey's remarks, he pointed out that the copper residues in Cornwall were mostly sulphides or oxides, and the extraction of the copper would involve a chemical process which would be more expensive than the mechanical separation of native copper. The speaker next asked several questions as to the section on the wall and how it was connected with the map. Was the dip shown in the section to the south-east or to the north-west? Was the dip in the two copper-bearing regions in the same or in opposite directions? Was the whole of the copper-bearing formation regarded as intrusive, or was some portion of it actually bedded, or altered sedimentary rocks? If the dip in the two regions could be given it would show whether the copper formations were the remnants of an anticlinal, as an apparent outlier seemed to suggest.

In replying to the discussion, Mr. Rathbone said that the Ball stamp was so peculiarly suited to the work because the native copper was tough and the machine was able to treat that and the ore without being disorganised. The questions raised by Dr. Bauermann, he would prefer to answer in writing, so the replies on this section will appear in the Transactions when they are published. Mr. Appleby's remarks as to the discharge of the stamp were, no doubt, correct, and the Californian stamp had a better discharge than the Ball machine. But against this was the fact that in following the Californian plan the wearing parts were increased, and as a matter of fact the machines were continually in the workshop. The only other material the Ball stamp seemed likely to be called into requisition for, was native gold. No doubt much valuable gold might be lost in the treatment, for leaf gold occurred in much the same manner as leaf copper. With the latter it was found that one per cent. was floated off, but an apparatus had been devised to meet this difficulty, and he would suggest that the same plan might be followed in gold. In the Transvaal there was a good deal of loss from washing away. To obviate this the speaker suggested a treatment by rolling which would have the effect of causing the gold to sink. With regard to Dr. Ryan's questions he would hardly have time to answer them in detail, so would refer that gentleman to the geological survey.

Pumping Engines at the Lincoln Water Works.

The secretary next read a paper on this subject which had been prepared by Mr. Henry Teague, of Lincoln. This contribution we shall publish in full next week.

The discussion was chiefly notable for eliciting a very unanimous expression of disapproval on the part of many of the engineers of the metropolitan water companies for the course Mr. Teague had followed in reinstating the old Boulton and Watt Cornish engines for water works purposes.

Mr. Bryan, of the East London Water Works, was the first speaker. He had, he said, under his charge the first Cornish engine erected in London for water works duty. It was put up forty-nine years ago. It was still working, and a source of constant anxiety, although constantly watched. The economy of the Cornish engine was more apparent than real, and the intermittent action was very trying on joints, &c. The high duty Worthington engine was, the speaker considered, the best for pumping into mains. The engine of Mr. Davey was also very good. He was surprised to find a Cornish engine again being put up. As to the valves illustrated, he thought the arrangement crude.

Mr. Restler, of the Southwark and Vauxhall Water Works, had also Cornish engines under his control, but apparently had no higher opinion of them than the previous speaker. He remarked that when the pressure was constant, these engines would be working at their best, but a reduction in the head would cause a great loss. He stated that he had obtained considerable advantage by compounding, but his company were now erecting a quadruple-expansion pumping engine to work with 180 lb. steam pressure.

Mr. Morris, of the New River Company, referred to the safety catches mentioned by the author, and stated that he had a Boulton and Watt engine built in 1812, and altered in 1850, which had safety catches fitted. Also with regard to the air vessel on the suction, he had under his charge an engine dated 1847, so fitted. He failed to follow the author in his figures as to saving in coal, and he thought the facts would not bear out the deductions. He preferred compound to single-cylinder engines for one reason, that they gave a more equable turning moment to the crank. In one crankshaft of a single-cylinder engine he had taken out, the metal was found to be so broken up as to resemble nothing so much as a bundle of sticks. He would prefer triple to quadruple compounds.

Mr. Mair read some extracts from a paper by Sir Frederick Bramwell, in which that gentleman condemned the Cornish engine, which might, the speaker thought, be good for pumping from deep mines, but was not suitable for surface pumping, especially into mains. He referred to the Worthington engine as the only type that meets the case of uniform flow. Mr. Davey referred to some pumping engines he had erected at Clay Cross Colliery, where he had secured uniformity of flow by not coupling the engines, but supplying them from one steam pipe with a single stop valve. The engines were direct-acting, and if one attempted to do more than its share of work it put a greater strain on the other. Of course he would not put an air vessel in this case, and in fact never fitted them unless with rotative engines.

Mr. Teague was not present to reply to the discussion, and this being the last paper, the meeting was brought to a close with the usual formal proceedings.

ROUGERIE'S ANÉMOGÈNE.

Some time ago we drew attention to the ingenious researches of Monseigneur Rougerie, Bishop of Pamiers, in France, who has been labouring to establish experimentally the theory that the rotation of our earth must be the principal cause of the currents and winds in our atmosphere. Ordinary text-books, such as used at schools, explain that the regular winds, the trade winds, and monsoons, for instance, are due primarily to the action of the sun; the rotation of the earth being regarded as a secondary factor. In Ganot's Physics the explanation is much as follows: "The air above the equator being gradually heated, rises as the sun passes from east to west, and its place is supplied by the colder air from the north or south. The direction of the wind, however, is modified by this fact that the velocity which this colder air has derived from the rotation of the earth—namely, the velocity of the surface of the earth at the point from which it started—is less than the velocity of the surface of the earth at the point at which it has now arrived; hence the currents acquire, in reference to the equator, the constant direction which constitutes the trade winds, *i.e.*, from the north-east on the northern, and the south-east on the southern hemisphere." This means, in other words, that the sun creates a wind from the poles to the equator, blowing from the north on our hemisphere; the rotation of the earth changes this wind into a north-east wind, but the rotation is not the cause of the wind.

Monseigneur Rougerie takes exception to this view. He does not at all deny that a great many atmospheric disturbances result mainly from differences in temperature. If air above a certain area is heated more than over adjacent spaces, it expands, becomes lighter, rises, and flows off in the higher altitudes towards the colder regions. The equilibrium at the surface of the earth is destroyed at the same time as the barometric pressure on the colder area is greater; we have, therefore, on the surface a current of cold air rushing towards the warmer spaces, the velocity of which depends upon the difference in barometric pressures. All winds so produced, however, even if we include the monsoons of the Indian Ocean, are of a local character. And since Monseigneur Rougerie has mechanically, without applying heat, imitated the monsoons, he is all the more inclined to assign the primary cause of the air currents to the rotation of the earth. Monseigneur Rougerie affirms that an artificial terrestrial globe, in rotation in the surrounding air, produces on its surface air currents similar to those of the atmosphere; and his "anémogène," or wind producer, shows the ordinary trade winds, the equatorial and tropical calms, the return trades, the moonsoons, &c., so that his theory, as we shall more fully see, is certainly based on good experimental data. His first rather primitive apparatus is illustrated in Fig. 1, page 151, which needs little explanation. The leather cord C D E passes over two pulleys D and E, and imparts motion to a vertical shaft on which the two globes A and A_1 are fixed. The frame F is of iron and about 18 in. high; the box G serves as a stand or case for the apparatus. The globe A (about 10 in. in diameter), was not perfectly smooth, but was provided with a number of meridional lines in relief, simply to produce a sufficient agitation of the air particles. Light fragments of down suitably suspended, or flames, were used to indicate the directions of the currents. The globe A' (3 in. in diameter) revolved in water in the basin B, and pieces of down compressed to free them from air, served as indicators. The speed of rotation appeared unimportant, though certain speeds showed certain phenomena best. The results were similar, both for the air and water media. On this point Monseigneur Rougerie states that "The rotation of a sphere in a medium less dense than itself, liquid or gaseous, always produces similar currents." Fig. 2 represents the results obtained, and shows the harmony between the wind currents produced with this primitive apparatus. In considering this diagram, we must bear in mind that the ordinary assumption explains those currents as arising from differences in barometric pressure due to differences in temperature, whilst Monseigneur Rougerie bases his theory on differences in air pressure directly due to the rotation.

We have already spoken of an ascending current in the equatorial region. This is the current *a a* of the sketch. The rising warm air flows back in the higher regions towards both poles, sinking slowly, and partly coming down to the surface at the tropics in a descending current (*i i*, Fig. 2), and returning towards the equator as trade winds from north-east and south-east (*e e*, Fig. 2) thus forming the first circular curve. The arrows *e e* point south and north, and the anémogène seems to be at fault on this point. In addition to the stronger currents marked *e e*, there is, however, another current not indicated in the sketch. As the air between the tropics travels more slowly than the globe itself, rotating from west to east, a current from the east is generated. This current combines with *e* to form the ordinary north-east or south-east trade wind. For the latitudes between the tropics and polar circles, we have mainly, on our hemisphere, south-west winds, the so-called return trades which have sunk down to the surface (*o o*, Fig. 2). MonseigneurRougerie explains the tendency towards the west in these latitudes by the air there having a greater velocity than the surface of the earth; his experimental evidence is, however, not strong on this point. The reaction to the return trade *o o* is an ascending current *u u* near the 60th degree, which partly returns towards *i i* and partly joins the original current from the equator towards the poles. Both united form at the poles a descending current *y y*, which afterwards reaches the surface as a southerly (or northerly) wind. These views account for the calm belts near the equator and the tropics, where the ascending and descending currents without horizontal motion are suddenly influenced by stronger trades and counter winds causing the violent tempests which characterise the so-called calms.

In the volume* in which the then Abbé Rougerie first advanced these theories, he based them mainly on the charts of M. Brault, which are used by the French Navy, and on the works of Le Gras, Privat-Deschanel and Focillon, Reclus, Glaisher, Maury, Gifford-Palgrave, and others. Somewhat fancifully he assumes, in analogy with the rings of Saturn and the belts observed on Jupiter, that our atmosphere extends to a greater height at the equator than at the poles, so that the earth should carry with it a sort of atmospheric ring. We cannot follow him here in his interesting calculations, by which he wishes to prove for the North Atlantic basin that the simple rotation suffices to produce the barometric differences and the respective winds with their mean directions and velocities;

* Les Courants Atmosphériques autour d'un Globe en Rotation. Limoges, 1879.

but we may mention that there exists a remarkable agreement between his calculated isobars and those deduced from the observations of Dr. Wojeikow.

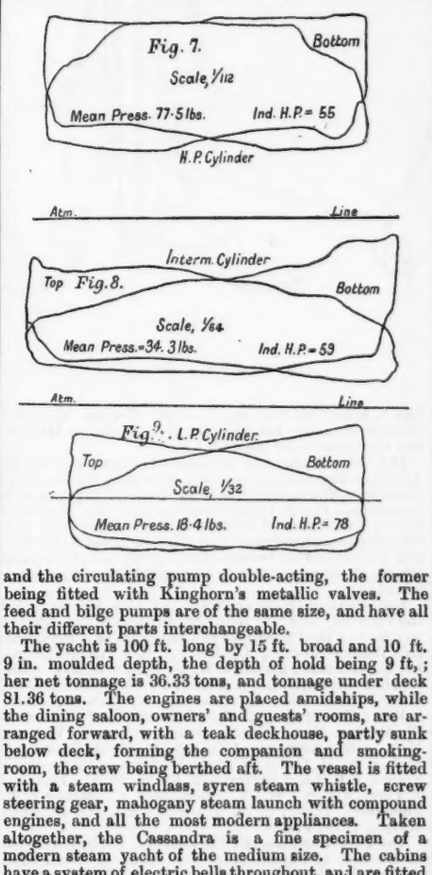
Monseigneur Rougerie soon replaced his first globes by a much larger one in relief, which he is still perfecting so as to make it more and more similar to our planet. This more recent anémogène, of which we give a view in Fig. 3, page 151, is a hollow sphere 1.28 metre (4 ft. 2 in.) in diameter, and supplied with little vanes placed 5 deg. apart. Ordinary vanes would permit of observations only after the globe has come to rest; little needles are therefore fixed to the shaft ends of the vanes, which on the inside of the globe mark the positions of the vanes; and the globe is composed of several spherical shell pieces, so that hundreds of observations may be taken in a few minutes whilst the globe is rotating. The assistant places himself inside the sphere and moves with it; a bell announces the number of rotations, that is, days. An equatorial velocity of 2 to 4 metres (6 ft. to 13 ft.) per second is supposed to be sufficient. The reliefs are as exact as possible, but a hundred times too high; this has been found necessary to make the vanes respond to the modifications which the relief of the continents effects in the wind directions. This new anémogène reproduces perfectly the trade wind on all oceans; the equatorial calms, their irregular distribution on the northern and southern hemisphere, and on the three oceans, and their sudden tempests; the transition of the north-east trades into the south-west monsoons of the Gulfs of Bengal and Oman; the great ascending current on the equatorial belt, and the line of minimum pressure there; the descending current of the Azores islands and the centre of maximum pressure there; a similar descending current directed towards the area of maximum pressure in the South Atlantic between St. Helena and the south coast of Africa; the two descending currents on the poles, right from the zenith, which must have a climatic influence; the south-east trade on the sea near Teneriffe, and the well-known wind from the west near the top of the Peak. There are also imperfectly reproduced: the variable winds which occur between the tropics and the 50th degree both north and south latitude; and also the winds in the zones between the 50th parallels and the polar circles. These imperfections cannot be wondered at. The apparatus is much too small, and the medium comparatively much too dense; the anémogène can never be more than a most modest approach to what the model of our planet ought to be. The main difficulty appears to be to give to the anémogène the proper atmosphere. The earth has a limited atmosphere, diminishing in density with the altitude; the anémogène is rotating in a medium of comparatively infinite extension which has a uniform density. Hence it probably results that the direct effects, the ascending equatorial currents, and the trade winds, are so well characterised; whilst the indirect effects, as the return trades, appear less distinct. Nevertheless, the results claimed must be called remarkable. That so easily explained a phenomenon as that of the monsoons, which simply appear to be land and sea breezes on larger scale, directly traceable to the sun's rays, should here appear as a necessary consequence of the rotation of the earth, will not be accepted without some hesitation; and as long as the experiments of Monseigneur Rougerie remain untested and unconfirmed, their apparent results will probably be questioned. Yet there seems no doubt that we must acknowledge the cardinal point of Monseigneur Rougerie's theory, that the rotation of the earth is the principal cause of our atmospheric currents and not the heat-rays of the sun. We need hardly mention that Monseigneur Rougerie fully grants the great importance of relief, character of the surface, and other local factors, and especially also of the sun-rays, but only in the second place. Whether the sun is thus to be partially relieved of one of his many onerous duties or not, further investigation will probably disclose. At any rate, the subject is a most interesting one.

ENGINES OF THE STEAM YACHT "CASSANDRA."

THE engravings on our two-page plate illustrate the engines constructed by Messrs. Kincaid and Co., Clyde Works, Greenock, for the steam yacht Cassandra, which was launched at the beginning of last season by the Culzean Shipbuilding Company, Limited. They were constructed to the order of Mr. James George Clarke, of Redholm, Wemyss Bay, and are of the triple-expansion type, the valves being worked by Joy's dual arrangement for triple-expansion engines, the principle of which is clearly shown in the illustrations.

The high and low-pressure valves, the former being a piston and the latter an ordinary slide valve, are worked by Mr. Joy's original gear off their respective connecting-rods, the heads of their spindles being connected by links to the ends of a beam. On a gudgeon fitted and securely fastened to the centre of this beam there is carried the intermediate valve spindle. This valve is also a piston valve, but unlike the high-pressure valve, takes the steam inside instead of outside; it will also be noticed that the travel of this valve is somewhat shorter than that of the other two, but this is compensated for by giving the ports a correspondingly larger area. All the working parts are made adjustable and of easy access, and on the trial the gear gave great satisfaction, and, as will be seen from the diagrams, the results could not have been better. The engines indicated 192 horse-power, with 150 lb. steam, and 147 revolutions, giving the vessel a speed of 11 knots.

The cylinders are 9 in., 14 in., and 22 in. in diameter by 15 in. stroke, and, as will be seen from the engraving, the arrangement of these and their respective valve casings saves a considerable amount of fore and aft space in a small vessel of this class. A great advantage is also gained by having the condenser pumps placed athwartships, thus equalising as nearly as possible the weights on each side of the centre line of the vessel, a point of very great importance in steam yachts, as it requires no trimming of ballast or coals to keep them on an even keel. The pumps are worked direct from the intermediate crosshead, the air-pump being single,



and the circulating pump double-acting, the former being fitted with Kinghorn's metallic valves. The feed and bilge pumps are of the same size, and have all their different parts interchangeable.

The yacht is 100 ft. long by 15 ft. broad and 10 ft. 9 in. moulded depth, the depth of hold being 9 ft.; her net tonnage is 36.33 tons, and tonnage under deck 81.36 tons. The engines are placed amidships, while the dining saloon, owners' and guests' rooms, are arranged forward, with a teak deckhouse, partly sunk below deck, forming the companion and smoking-room, the crew being berthed aft. The vessel is fitted with a steam windlass, syren steam whistle, screw steering gear, mahogany steam launch with compound engines, and all the most modern appliances. Taken altogether, the Cassandra is a fine specimen of a modern steam yacht of the medium size. The cabins have a syatem of electric bells throughout, and are fitted up in walnut, mahogany, Hungarian ash, and polished oak; the ceilings and cornices are of lincrustra. The yacht was designed by Mr. W. Fife, Jun., of Fairlie, under whose superintendence her building and completion were carried out.

NOTES FROM BERLIN.

BERLIN, February 14, 1887.

THE war rumours have had a most depreciating effect upon trade in all directions. In many cases, orders have either been cancelled altogether, or greatly reduced, and new commissions are difficult to secure.

There is not much change to report in the Rhenish Westphalian iron industry; trade is still fairly satisfactory, and when the political scare dies away it is probable that a number of furnaces will be relighted. Pig-iron prices were recently advanced another shilling per ton all round. The import of foreign iron ore is largely developing, much to the detriment of home producers, who have had to lower their prices again. Last year's import of this commodity showed a slight decrease on 1885, but it seems very probable that the next returns will show a substantial increase if matters continue as at present. Several blast-furnace owners in the Luxemburg district are in treaty with Westphalian mines for a renewal of the sliding scale for coke prices. The exceptional demand from abroad for drawn wire is still kept up, and increased prices are obtained. Steel works are fairly busy with the orders on hand, consisting chiefly of billets for North America. In the rail department the effects of the war rumours have been severely felt. A Canadian railway company is desirous of placing in Europe a contract for 50,000 tons, and German makers' chances of securing the order were thought very rosy, but it is reported that the company would not care to place the order in Germany under present circumstances, as in case of war it is feared that difficulties would be experienced in its execution. Railmakers need not now have much fear of foreign competition, as the Minister of Trade has officially intimated that foreign offers for State railway contracts will not be considered, although they may be lower than the home tenders. Foreign firms did not compete for the 3000-ton contract of the Erfurt Railway Direction, which was divided between the Bochumer Company and the Orinsdorf Marien Company.

The iron industry in Upper Silesia is in a fairly satisfactory condition; pig-iron prices were recently increased. Steel manufacturers have plenty of orders on hand at fair prices. Rolling mills have just established a convention for the controlling of the production and prices.

The coal trade generally has experienced a slackening since the warmer weather set in. The general improvement of trade, however, is noticeable from the increased demand for steam coal. The German Edison Electric Light Company, at a recent meeting, resolved to increase its capital from 250,000*l.* to 350,000*l.* This firm is closely connected with the City Electric Light Company, who have in view the carrying out of further installations in Berlin, and it is understood that the increase of the capital of the former firm is in this connection. Messrs. Siemens and Halske, of Berlin, have secured the contract for an electric light installation at Elberfeld. An elevated railroad is projected from this latter town to Barmen, and seems in a fair way of becoming a matter of fact. Building operations are being carried on extensively in Berlin just now. In some cases the electric light is brought into requisition, and both day and night work is carried on. Several Japanese artisans are in Berlin at present, being initiated into the mysteries of the building trade. They have come over specially for this purpose, and will shortly return to Tokio to work at the new Government buildings to be erected in that capital. A number of German tradesmen have been engaged by the Japanese Government in connection with these buildings, besides two or three well-known architects.

Telephone wires in Germany are generally made of steel, being considered more durable when of this material. This supposition was fully confirmed after the recent memorable snowstorm, as steel wires were found to have scarcely suffered any injury. The results of the investigations of the general authorities on the matter of telephone wires, occasioned by the same snowstorm, have just been published. It is found that phosphor-bronze wires are of but little worth; steel wires showed very favourable results, but those of silicium bronze were proved to be very far the best in every way.

A Berlin firm, who are extensive importers of naphtha, have arranged for large quantities to be shipped from Russia to Stettin, in vessels specially equipped for the liquid-carrying trade. A pumping station will be erected at the discharging place near Stettin, and the naphtha conveyed from there by small river boats, which will be specially constructed for this purpose.

The shipping trade seems improving; two or three of the large steamship firms have recently given commissions in Germany and England for new vessels. A project is on foot for the establishment of a new steam service between Hamburg and Australia. The Vulcan Company, at Stettin, have nearly completed the vessels for the Chinese Government, which they have had on hand for some time. This firm was unable to declare a dividend for 1886, but it is expected that this contract will exercise a favourable influence on the next returns. By the explosion of a high-pressure cylinder, which was being tested, five men were recently severely injured at the Vulcan Engine Works. The returns of the Berlin Tramway Company for last month show an increase of 436*l.* on January, 1886. The Berlin Omnibus Company, although suffering from the competition of the tramways, managed to pay a dividend of 10 per cent. for last year.

GAS POWER.—The Gasmotoren Fabrik at Deutz, have recently made a very successful trial of a double-cylinder Otto engine which gave a brake power of about 60 horse-power when driven with Dowson's fuel gas. They are now making a four-cylinder Otto engine which will not only develop over 100 horse-power effective, but will have an impulse at every stroke. It will thus be seen that a considerable advance is being made in the sizes of gas engines now that Dowson's gas has been proved suitable for them, with a lower fuel consumption per horse-power than is possible with steam engines of equal power.

THE GATMELL EXCAVATOR.

CONSTRUCTED BY MR. H. J. COLES, ENGINEER, LONDON.

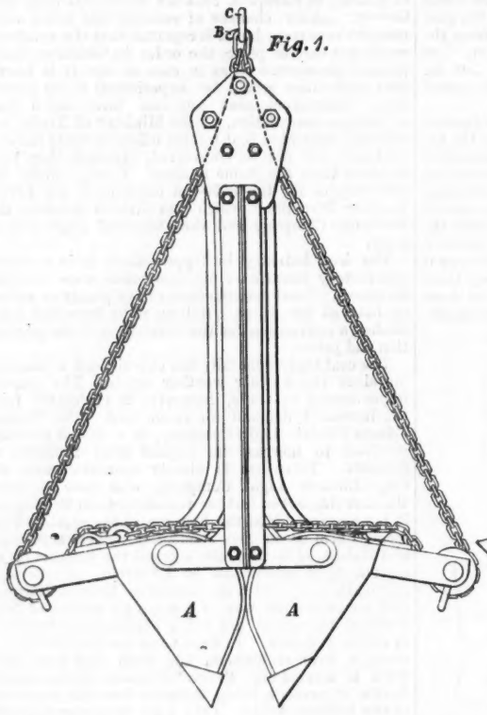


Fig. 1.

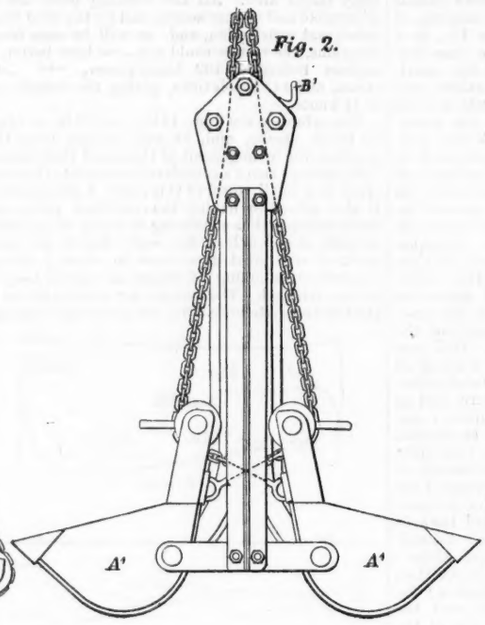


Fig. 2.

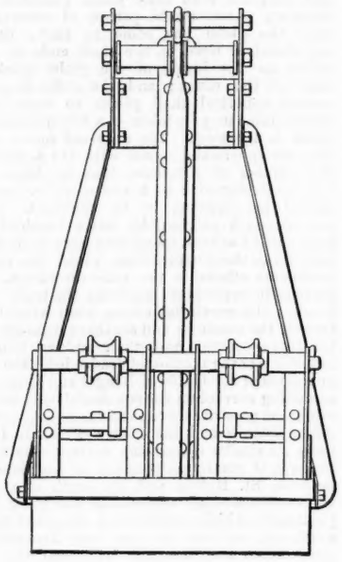


Fig. 3.

The illustrations above represent a type of excavator, originally devised by the late Mr. Gatmell, for sinking cylinders on the Empress Bridge over the River Sutlej. Fig. 1 is a side elevation of the excavator in the position in which it descends preparatory to excavating; Fig. 2 is a side elevation showing the position of the buckets when filled; and Fig. 3 is a front elevation of the excavator when filled.

The excavator is attached to the chain of the crane or hoisting engine, by the ring C, the hook B also catching into this ring, so that the buckets A A may be free to assume the position shown in Fig. 1. The excavator is then lowered until the edge of the buckets rests on the material to be excavated, when the hook B falls out of the ring C. The chains are then drawn upwards, either steadily, or by a series of jerks, according to the nature of the material which is being excavated. This action causes the buckets to excavate the ground and to fill themselves at the same time, until they reach the position shown in Fig. 2, when the whole is drawn up to the surface. The contents are discharged by lowering the excavator on to a platform and engaging the hook B with the ring C, when, on tightening the lifting chain, the buckets fall downwards, relieving themselves of the spoil and assuming the position shown in Fig. 1. They are then ready to descend for a fresh charge.

Where greater expedition is required for discharging, the excavator may be fitted with an automatic apparatus for relieving the buckets of their load.

The buckets may be replaced by suitable tines with pickaxe-points for breaking hard substances, the action remaining precisely the same as previously described. A modification of the same arrangement is employed for undercutting the edges of concrete cylinders; one-half of the excavator, which is slung independently so as to hang at an angle, and is made to operate at any point of the edge of the cylinder by moving the sling.

The excavators, which are manufactured by Mr. Henry J. Coles, of Southwark, London, are constructed in a most substantial manner so as to withstand the roughest usage without incurring stoppages for repairs, all the parts being made as weighty as practicable, so as to provide sufficient power for excavating the hardest material.

THE PHYSICAL SOCIETY.

The annual general meeting of the Physical Society, was held on February 12th, Professor B. Stewart, F.R.S., President, in the chair.

In opening the proceedings the President regretted that in their report the Council had to record the loss of one who took a prominent part in the proceedings of the Society, the late Dr. Guthrie. It was, however, satisfactory to learn that the appeal of the Guthrie Memorial Committee, under the presidency of Professor Huxley, had been generously responded to.

The Council also had learned with regret from Dr. E. Atkinson, that owing to pressure of work he was unable to retain the office of treasurer to the Society, and desired to express their thanks to him for his past services. Professor Rücker had consented to be nominated for the office thus rendered vacant, and the Council believed that by his election the connection between the Society and the Normal School of Science (which is so desirable) would be maintained.

The report of the Council for the year 1886 was read and received, and the following gentlemen were elected members of the Council for the present year. President, Dr. Balfour Stewart, LL.D., F.R.S.; vice-presidents, Dr. E. Atkinson; Professor W. E. Ayrton, F.R.S.: Shelford Bidwell, M.A., LL.B., F.R.S.; Professor H. McLeod, F.R.S. Secretaries, Professor A. W. Reinold, M.A., F.R.S.; Walter Baily, M.A. Treasurer, Professor A. W. Rücker, M.A., F.R.S. Demonstrator, C. V. Boys, M.A. Other members of Council, R. H. M. Bosanquet, M.A.; W. H. Coffin; Conrad W. Cooke; Professor G. Forbes, F.R.S.E.; Professor T. Fuller, M.A.; Professor J. Perry, F.R.S.; W. N. Shaw, M.A.; Professor S. P. Thompson, D.Sc.; C. M. Whipple, B.Sc.; C. R. Alder Wright, D.S., F.R.S.

The President proposed the following resolution: That at the end of Clause 11 of the bye-laws, which says, "Every candidate for admission into the Society shall be recommended by not less than three members, to two of which he must be personally known," there be added, "when a candidate living abroad is a member of a recognised scientific society, such membership may, subject to the approval of the Council, be held equivalent to the personal knowledge aforesaid." The resolution was carried subject to confirmation by a special general meeting to be held on February 26. A vote of thanks proposed by Professor Ayrton and seconded by Professor McLeod, to the Lords of the Committee of Council on Education, for the use of the rooms and apparatus of the Normal School of Science, was passed unanimously. The Hon. R. Abercromby proposed a vote of thanks to the officers of the past year for their gratuitous services, which was seconded by Professor Pickering. Sir Phillip Magnus proposed a vote of thanks to the auditors, Colonel Festing and Professor Fuller, which was seconded by Mr. Lecky, and passed unanimously. Mr. J. Brown was elected a member of the Society. The following communication was then read.

"*Note on the Tenacity of Spun Glass*," by E. Gibson and R. E. Gregory. The authors have experimented on the tenacity of glass rods and fibres made from the same piece of glass. The fibres varied from $\frac{1}{15}$ mm. to $\frac{1}{55}$ mm., and the rods from about $\frac{1}{2}$ mm. to 1 mm. in diameter. They find the tenacity per sq. c.m. of rods increases as the diameter decreases as in ordinary wires, whereas with fibres this is not shown. Experiments were shown illustrating the method of working; and the highest tenacity recorded was for a fibre of .0340 mm. diameter, which gave 466×107 deg. per sq. c.m., a value about half as great as that for steel wires. The authors refer to Quincke's suggestion that the increased tenacity of small wires is due to surface tension, and may be represented by $W = A\,d + B\,d^2$, where W is the breaking weight and D the diameter, but their own results with glass do not agree with this formula. Sir Phillip Magnus asked if the diameters were measured at the point of rupture, if the elongation was determined, and whether the authors were able to suggest any other formula which would express their results. Mr. C. V. Boys remarked that the tenacity being so much affected by accidental circumstances, such as rate of cooling, no such formula could be expected. Professor Rücker, referring to Quincke's experiments, said that the surface tension of metals calculated from them appear improbable. After some further remarks by the President, Professor Ayrton, Mr. C. V. Boys, Professor McLeod, and Mr. Gregory, the proceedings terminated.

LAUNCHES AND TRIAL TRIPS.

On Tuesday, 8th February, Messrs. Alexander Stephen and Sons, Dundee, launched the Doris, a composite barque, the frames being of iron and the plating of steel. The Doris, which is owned by the builders, measures 243 ft. by 35 ft. 2 in. by 23 ft. She is a vessel of 1375 tons gross register, and is to be fitted with all the most approved appliances for her safe working at sea and for rapidly loading and discharging cargo. It is the intention of her owners to employ her in the sealing and whaling trade. Messrs. Stephen and Sons are about to lay down a sailing ship of 2000 tons.

Steel Rails in Holland.—An adjudication for 3000 tons of steel rails and accessories has just taken place in Holland. The lowest tender was that of the Steel Works Company of France, 17,262*l.* Bolckow, Vaughan, and Co. (Limited) tendered at 19,663*l.*

The Hudson Bay Railway Scheme.—A correspondent writing from Ottawa at the end of January states that the Hudson Bay Railway enterprise is daily gaining ground, and that public admiration is expressed for the energy of its promoters and for its principles. The latest news in this connection that had been received at Ottawa was, he says, that the first steamship to ply on the new ocean route which the railway will open, had been launched, and named Port Augusta. She is a steel-plated vessel of 3000 tons, specially built for the new trade, and will have accommodation for 1000 passengers. A sister ship, the Port Nelson, will be launched in the month of March, and two other steamers are being fitted out—the Maharajah and Sir Richard Corry. The first voyage is to be made in the early part of June, as an experimental trip, and the vessel will take out a cargo of rails, of which some two thousand tons are waiting shipment. It is stated that if the provincial guarantee is adopted by the Manitoba Legislature satisfactorily to British capitalists, an additional 200 miles of railway will be constructed during the ensuing summer.

VIADUCT OVER THE RIVER RETIRO, BRAZIL.

MR. JORGE R. GRÜNEWALD, ENGINEER.

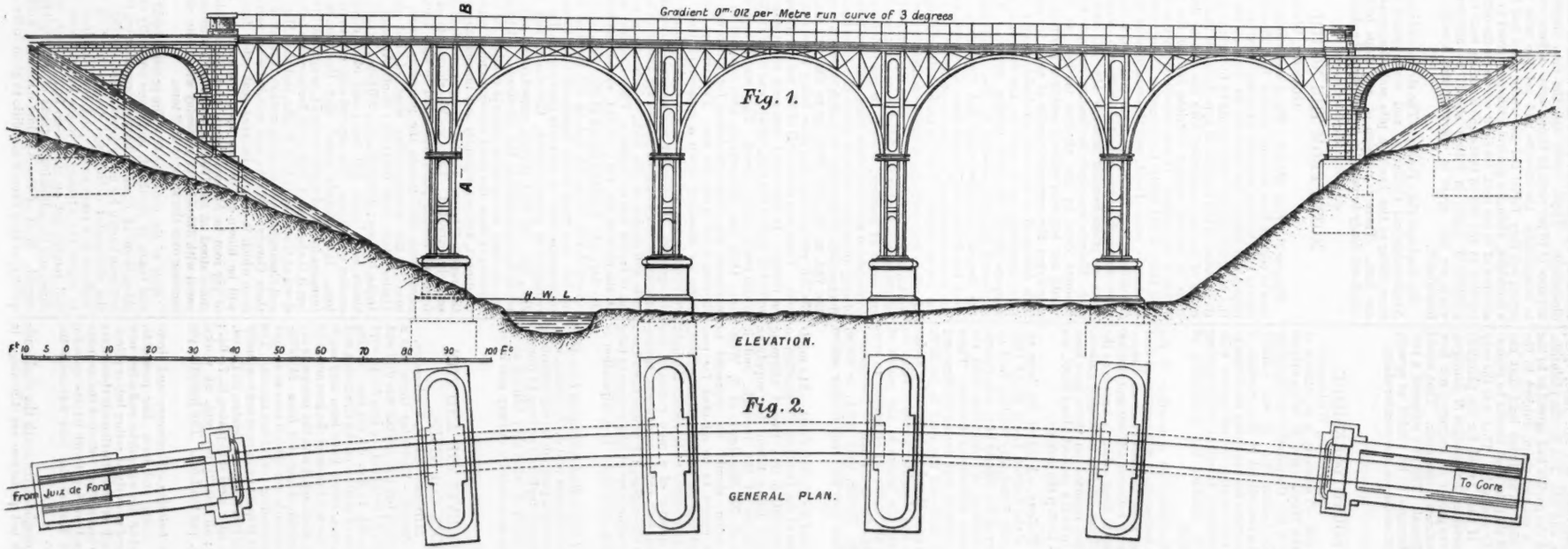


Fig. 1.

Fig. 2.

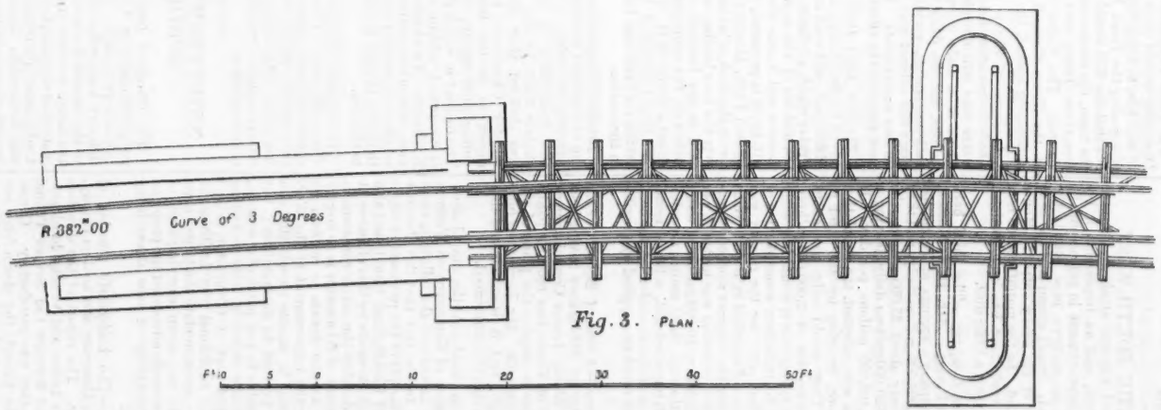


Fig. 3. PLAN.

We give above, and on page 158, engravings of the viaduct over the River Retiro, Brazil, our illustrations being reproduced by permission from the Proceedings of the Institution of Civil Engineers. In a "selected paper" contributed to the volume of these Proceedings just published, Mr. Jorge Rademaker Grünewald, Memb. Inst. C.E., describes the work as follows:

This viaduct was constructed in the year 1875, according to designs furnished by the author, for the purpose of passing the Dom Pedro Segundo State Railway over the valley which forms the bed of the River Retiro, a small confluent on the left bank of the River Parahybuna. It is 265 kilometres (165 miles) from Rio de Janeiro, and about 10 kilometres (6.4 miles) from the city of Juiz de Fora, in the province of Minas Geraes, Brazil. It has a curve of 382 metres (1253 ft.) radius, and a gradient of 1 in 83.3. Its total length is 109 metres (357 ft. 7 in.); width between handrails, 4 metres (13 ft.); and greatest height above the bed of the river, 20 metres (65 ft. 7 in.).

The viaduct is composed of seven semicircular arches, each end arch being built of ashlar masonry, and of 6 metres (19 ft. 8 in.) diameter; five intermediate arches, 15 metres (49 ft. 2 in.) in diameter, are of iron. The four central piers are of iron erected on pillars of ashlar masonry. The metallic part of this viaduct is 80 metres (262 ft. 6 in.) long, and is constructed in the following manner: The arches, and the longitudinal girders which they support, are made of two Barlow rails rivetted together, with an iron plate ½ in. thick placed between them. The spandrels are formed of uprights and diagonals, the former being made of four angle-irons, and the latter of one angle-iron. Each pair of arches, longitudinal girders and uprights, is transversely 3 metres (9 ft. 10 in.) from centre to centre, and is connected by cross and diagonal bracing. On the top of the longitudinal girders are fixed cross-pieces of single Barlow rails, upon which again are fastened two longitudinals of wood 12 in. square in section, and which in their turn carry the rails of the permanent way.

The gauge of the Dom Pedro Segundo Railway is 1.60 metre, or 5 ft. 3 in. nearly, between the rails. At each end of the transverse Barlow rails is fixed the customary simple iron handrail carried by light cast-iron standards. The iron piers are each formed of four columns, and the columns consist of two Barlow rails, with a slotted iron plate ½ in. thick let in between the rails, and the

whole being rivetted together, connects each pair of side columns.

The details show the system of cross and diagonal bracing. The columns are each supported by four buttresses formed of plates and angle-irons. These buttresses, fastened with bolts 8 ft. 3 in. long, let into the masonry pillars, secure the stability of the viaduct against lateral strains, due mostly to the centrifugal force caused by the passage of the trains.

The Barlow rails, which constitute the peculiarity of the structure, are from those taken up from the permanent way when the Vignoles pattern of rail was adopted on this railway. The whole of the foundations were built without difficulty. The principal parts of the ironwork were calculated to resist the strains resulting from a weight of 4 tons 8 cwt. per lineal metre, travelling over the viaduct at a velocity of 60 kilometres, or about 37 miles per hour.

In spite of its fragile appearance this viaduct has, up to the present time, served in a most satisfactory manner the purpose for which it was built.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Last week's coal exports attained the considerable total of 160,000 tons, and an impression is beginning to prevail than an improvement in prices will be shortly witnessed. Even as matters now stand, the markets are firmer all round. Small steam coal has been rather weak in consequence of the heavy output. House coal has been in good demand. In the manufactured iron and steel trades rather a weak tone has been noticed. The iron ore trade has also been a little dull.

West Gloucestershire Water Company.—The third half-yearly meeting was held on Friday. Mr. H. J. Marten, the engineer, said the company's springs at Frampton Cotterell yielded at least 3,000,000 gallons daily, and they had in their present area only about 35,000 people, who could only consume about 600,000 gallons daily, leaving a surplus of 2,300,000 or 2,400,000 gallons per day. If a proposed extension of area were adopted, the population would be about 25,000 more, bringing up the total to something like 60,000. They would only use about 1,000,000 gallons, leaving a surplus of 2,000,000 gallons, and he had no hesitation in saying that it would be greatly to the advantage of Bath to introduce some portion of that surplus water into that city, for the quality was superior to anything at present supplied in Bath. With regard to the works generally the engines worked economically, and the coal bill for pumping was under 1*l.* per week. The company could deliver 10,000 gallons of water from Frampton Cotterell through their mains, six miles in length, to the top of Kingswood-hill, a lift of something like 240 ft.—300 ft. with friction—for 3d. for coal. The highest parts of Bristol could be supplied by gravitation from their tank.

A Breakwater at Mevagissey.—A loan of 20,000*l.* for the construction of a breakwater at Mevagissey having been sanctioned by the Public Works Loans Commissioners, Mr. Barnes, of the Board of Trade, has recently paid a visit to the place, in order to inspect the plans of the engineer, Mr. Inglis, of Plymouth. Mr. Barnes has fully approved Mr. Inglis's design, and it is anticipated that building operations will be shortly commenced.

Worcester and Birmingham Canal.—At the annual meeting of the Gloucester Chamber of Commerce on Wednesday, Mr. T. Nelson Foster introduced the following resolution: "Having regard to the fact that this chamber has already adopted the principle of the proposed enlargement of the Worcester and Birmingham Canal, and also looking to the strenuous efforts made by this chamber at all times to maintain and develop the water communication, and upon which the trade of Gloucester is so largely dependent, this chamber hereby desires to reaffirm its approval of the project for the improvement of the Worcester and Birmingham Canal to enable vessels that can now reach Worcester to proceed to Birmingham; but without pledging the chamber to any particular scheme, it is of opinion that, with the object of fully protecting the interests of the city and port of Gloucester, it is of imperative importance that additional port facilities be simultaneously provided to accommodate the larger class of vessels now employed in the ocean carrying trade of this country." Mr. Foster strongly advocated the proposed improvement and the advisability of new docks being established at Shepperdine.

Great Western Railway.—The half-yearly meeting of the Great Western Railway Company was held on Friday, Sir D. Gooch in the chair. The report of the directors stated that eighteen goods trains and twenty local passenger trains now passed through the Severn Tunnel daily, and that the ventilation was satisfactory. Consequent on the opening of the tunnel, the steam ferry service between New Passage and Portskewett had been discontinued. A vote of the proprietors was asked for the following expenditure: Bodmin branch and Boscarne extension, 10,000*l.*; Bristol, opening out No. 1 tunnel, marshalling sidings, &c., 50,000*l.*; Bristol and South Wales Union Railway, doubling, 5000*l.*; Cardiff, additional accommodation, 25,000*l.*; joint lines and stations, 20,000*l.*; Kendal and Tetbury Railway, 10,000*l.*; Plymouth Docks, 5000*l.*; Quaker's Yard to Merthyr joint line, 10,000*l.*; Shipston and Morton Tramway, 15,000*l.*; locking gear, 20,000*l.*; workshops and machinery, locomotive and carriage department, 15,000*l.* The report was adopted.

Swansea Dry Dock.—The South Wales Assizes disposed on Friday of the case "The Central Graving Dock Company (Limited), Swansea *v.* Walker." The plaintiffs sought to recover from the defendant something like 24,000*l.* for damages sustained through alleged breaches of contract in the construction of the Swansea dry dock. Mr. M'Intyre. Q.C., Mr. Moulton, Q.C., and Mr. Benson were for the defendant, and Mr. Reid, Q.C., M.P., Mr. Abel Thomas, and Mr. Fox for the plaintiffs. Mr. M'Intyre stated that the parties had agreed as to the amount of damages on a counter-claim, subject to the verdict of the jury, viz., 650*l.* The judge held that the contract was to the effect that the dock should be permanently dry and thoroughly workable. That was the only question for the jury. If they found for the plaintiffs they would not have to consider the question of damages, whether the materials were proper or improper, nor how much it would cost to construct a new dock. That would be matter for another tribunal. The jury returned a verdict for the plaintiffs, damages to be settled as agreed, the arbitrator to take 650*l.* as due on the counter-claim.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

The Trent Navigation Bill.—Yesterday a deputation at Doncaster waited upon the Mayor (Mr. H. Wainwright) to urge him to bring before the Corporation the necessity of opposing the Trent Navigation Bill. It was pointed out that the Bill would be prejudicial to the interests of the town, the scheme being one for acquiring the hitherto free river Trent, and the levying of navigation tolls thereon. The Mayor undertook to call an early meeting of the Town Council to consider the desirability of petitioning against the Bill.

Leakages at Eccup Reservoir.—At a meeting of the Leeds Corporation held last week, it was mentioned that water was still escaping from the reservoir at Eccup. There is a daily waste of between 500,000 and 600,000 gallons, and the daily waste from what is known as the national spring, varies from 370,000 to 395,000 gallons. Since the subject was last reported on there have been further experiments. Up to the present about 3500*l.* has been expended in efforts to stop the leakage.

The New High Peak Railway.—A letter has been received by the chairman of the Buxton Local Board (Mr. Millingan), and read at the fortnightly meeting held on Friday night, explanatory of the objects in view as regards the making of the new railway in connection with the London and North-Western Railway at Buxton. There will be, it is proposed, a viaduct over Spring Gardens and Lyham Park, the centre arch over the road to be 50 ft. above the road, a bridge over Hogshaw-lane, and a bridge over the lane leading to the slaughter-houses. With regard to the footpath over the bridge in the parish of Bakewell, the company are under an obligation to construct a bridge 36 ft. wide for the Duke of Devonshire. The Board requested Mr. Taylor, their clerk, to write, asking for drawings before they took any further action in the matter.

Bradford Corporation and the Electric Light.—At a meeting of the Gas Committee of the Bradford Corporation on Saturday morning, a resolution was passed affirming the desirability of steps being taken for supplying electric light in the centre of the borough, and it was decided that Mr. J. N. Shoolbred, of 3, Westminster Chambers, London, should be requested to report as to the best course to be adopted for providing such supply, and also as to the estimated cost. The district in which it is proposed to introduce the light is comprised within a quarter of a mile radius of the Exchange. To circulars sent out to merchants, tradesmen, and others within this radius, 111 replies have been received expressing the willingness of the writers to take the light, though in many cases there is a stipulation as to the cost.

The Suggested Elevated Single-Rail Railway to Roundhay Park.—Messrs. J. Clark Jefferson and J. T. Pullan, civil engineers, Leeds, have issued a pamphlet, fully describing their scheme for an elevated single-rail railway to Roundhay Park, with a comparison of what they believe to be its advantages over other proposals for railway and intercommunication.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday there was a good attendance on 'Change, but the market was dull and prices were weaker. No. 3 Cleveland pig iron for prompt delivery was quoted 35s. 6d. to 35s. 9d. per ton. Owing to the unsettled situation of politics on the Continent and the labour troubles at home, values have been very much disturbed recently, but the conditions of the iron and steel trades generally remain unchanged and the prospects are still favourable. Shipments of pig iron from Middlesbrough up to date this month are 24,500 tons as against 17,000 tons at the corresponding period last month. The manufactured iron trade is quiet and prices are nominally the same as those quoted last week, viz., plates, 4*l.* 17s. 6d. per ton; angles, 4*l.* 12s. 6d.; steel ship-plates, 6*l.* 7s. 6d.; and angles, 5*l.* 17s. 6d.; all less 2½ per cent. at works. Steel rails are 4*l.* 7s. 6d. per ton f.o.b. The hematite pig trade remains steady.

Engineering and Shipbuilding.—Engineers and iron-founders report more doing and have fair prospects. Shipbuilders are receiving more inquiries and a few new steamers have been placed recently at rather better prices. On the Tyne, Wear, and at the Hartlepools there have been launches since our last notice. Most of the steamers launched are of steel and are fitted with triple-expansion engines. It is believed that as the year advances the shipyards will be busier.

The Steel Trade.—Throughout the north the steel trade not only continues brisk but quotations are stiffening. It is satisfactory to record the settlement of the strike at Bolckow, Vaughan, and Co.'s steel works at Eston, Middlesbrough. Three weeks ago the men struck for an advance of 10 per cent. in their wages. Efforts were made to compromise the dispute and get the men to work again, but they failed till the whole place had been idle a fortnight, when the general manager agreed to grant an advance of 2½ per cent. for eight weeks on the understanding that at the end of that time a sliding scale for the regulation of wages in future should be adopted. The works are now again in operation and a scale is being formulated.

The Coal and Coke Trades.—The strike continues at the Northumberland Collieries, and consequently there is more doing at the Durham pits and coke ovens. Prices are firm. There is no sign of any steps being taken which are likely to result in terminating the strike.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig-Iron Market.—There was considerable flatness in the pig-iron warrant market last Thursday, merchants and brokers scarcely knowing what to do. The impression during the forenoon was that by the close of the week the miners' strike would be brought to a terminations owing to the number of apprehensions that had been made of persons connected with the riotous demonstrations in several mining districts, and to the energetic action of the police. It was rumoured in the afternoon that there would likely be a number of furnaces put out of blast for want of coal, and this caused more firmness at the close. Very little legitimate business, however, was done, and such as was reported in Scotch warrants took place at prices ranging between 44s. 1d. and 44s. 3d. cash. Flatness was again the leading characteristic of the business done in the pig-iron market, as consumers would not buy iron without seeing a prospect of being able to get the necessary supply of coals for working it. This falling off in demand, no doubt, largely kept iron from mounting up in price in the way that generally happens during all great mining strikes. The price of Scotch iron fell steadily to 43s. 10½d. cash, being the lowest quotation since last December. On the week the decline was 5d. per ton. Cleveland and hematite warrants showed a decline respectively of 3d. and 4½d. per ton on the day. The iron trade continued depressed on Monday, and stoppages of various malleable iron and steel works, owing to want of coal, were reported. It was currently rumoured that four blast furnaces at one ironworks and three at another, were to be damped down, and the consequence was that prices were sent up a little, but the closing quotations were at about the lowest point. The fluctuations in the price of Scotch warrants ranged from 43s. 7½d. to 43s. 6d., then up to 43s. 9d., and down to 43s. 5d. per ton cash, the close being buyers at 43s. 5½d. cash. There was thus a fall of 5d. per ton from the close on Friday. In Cleveland iron only one transaction was recorded during the day, which was done at 35s. 3d., at which price buyers closed. This was a drop of 6d. per ton. Only two transactions were reported in hematite warrants, the closing quotation for which was 48s. cash, showing a fall of 6d. per ton. Preparations having been made for damping down a number of blast furnaces, yesterday's warrant market was slightly firmer in tone at the opening. The market was somewhat irregular, prices opening at 43s. 6d., going to 43s. 4½d., then up to 43s. 8½d. cash, and closing at 43s. 6½d., which was a recovery of 1d. of the 5d. lost on Monday. Cleveland iron was quoted at the close at 35s. 4½d., or 1½d. under the best price of the day, and hematite closed at 48s. 4½d., showing a recovery of 4½d. of the 6d. lost on the previous day. The market was very much depressed this forenoon, and considerable sales of warrants were reported at a further reduction in prices—Scotch, Cleveland, and hematite, 2½d., 4½d., and 10½d. per ton, respectively; and still lower prices were accepted in the afternoon. At present there are no very encouraging reports coming to hand from America or from the great iron-consuming centres on the Continent, and consequently any immediate repetition of the recent "boom" in the Glasgow pig-iron market is scarcely expected. Last week's shipments of pig iron from all Scotch ports amounted to 6330 tons, as compared with 5667 tons in the preceding week, and 7852 tons in the corresponding week of last year. The United States took 1640 tons; South America, 150 tons; India, 115 tons; Australia, &c., 230 tons; France, 176 tons; China and Japan, 100 tons; and other countries took smaller quantities. The amount sent coastwise was 2698 tons. It is officially stated that the number of blast furnaces in actual operation is 74, as against 94 a year ago, but it is also stated that seven furnaces are being damped down at Gartsherrie Iron Works, and that Messrs. Merry and Cuninghame have given notice that all contracts at their Carnbroe Works will terminate in fourteen days, from which it may be inferred that other four furnaces will be blown out or put upon slack blast. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood at 842,169 tons yesterday afternoon, as compared with 843,601 tons yesterday week, thus showing an increase over the week of 1432 tons.

State of the Coal Trade.—The present condition of the coal trade of Scotland, and more especially of Lanarkshire, is one of extraordinary disorganisation, such as has not been known for many years. The districts in which the disgraceful rioting and shop-looting took place last week are now remarkably quiet, but the miners generally, to whom the advance of wages has not been conceded, still remain out on strike—so far, at least, as Lanarkshire, and the adjoining districts of Stirlingshire are concerned. Most of the Ayrshire miners are working away quietly, as they deem it impolitic to go on strike at present

or to go through the form of taking "holidays," in the hope of securing an advance of wages. In Fife and Clackmannan almost the whole of the miners have given in their notices to terminate their present contracts, so that they may be freed from the "conditions of employment" by which they have been bound since the Mines Inspection Act came into operation. By way of out-manœuvring the miners the Associated Coalmasters of the two counties are preparing to adopt very drastic measures. In many instances they have large stocks of coal at the pitheads, and these are being freely drawn upon in order to meet the demands which are so pressing in the Glasgow district and in other parts of Scotland. The Fife and Clackmannan coalmasters are at present reaping a rich harvest, as they are able to command almost any price they care to ask. Some of the Lanarkshire coalmasters who have any stocks—even of very inferior stuff—or who have retained their miners at work by giving the advance of wages, are also securing excellent terms for their coal; and where the material passes through the hands of middlemen very extortionate charges are being made. One hopeful feature of the present crisis in the coal trade is the fact that every morning and afternoon newspaper announces that the advance of wages is being conceded at additional collieries throughout Lanarkshire and Stirlingshire. On the other hand, many of the coalmasters seem to be determined to resist to the bitter end. Negotiations were opened a few days ago by some neutral parties who desired to bring about a conference between representatives of the coalmasters and the miners, in the hope that they might agree to have the matter in dispute submitted to arbitration, but up to the present those well-intended efforts have been fruitless in results.

Extensive Engineering Orders for Greenock.—Messrs. Rankin and Blackmore, Greenock, have just concluded a contract to supply six sets of machinery, consisting of twelve pairs of compound surface-condensing engines, which are intended to be fitted on board of six twin-screw gunboats, now in course of construction in India for shallow river and coasting purposes. Each pair of engines will indicate about 130 horse-power, and the working pressure of the steam is to be 100 lb. per square inch. The engines have been specially designed to suit vessels of a very limited draught of water, being of the lightest character possible, consistent with safety, and they are intended to secure a high rate of speed.

East of Scotland Engineering Association.—An ordinary meeting of this Association was held in Edinburgh last night, at which a paper on "The Creosoting of Timber" was read by Mr. T. Carswell. After describing the process usually adopted, the author showed that it was alike profitable and desirable that the timber should first be well dried. The harder woods, such as oak and beech, could also be creosoted. For the illustration of his paper, Mr. Carswell exhibited specimens of creosoted and uncreosoted timber which had been in use from six to thirty-four years. A discussion followed.

Forth Bridge Railway Company.—The half-yearly meeting of this company was held yesterday in Edinburgh, Mr. J. Hall Renton (chairman) presiding. In moving the adoption of the half-yearly report, the chairman expressed regret that the fifteenth quarterly report on the condition of the bridge by the Board of Trade inspectors had only come into the possession of the company last Saturday, although it was dated November 27, 1886. He also mentioned some interesting facts regarding the progress of the work up to date, and stated that the engineers confidently expected that the bridge would be completed towards the middle of 1889. The engineers' report, dated January 7, 1887, states that the twelve main piers are complete. On the north side of the Forth the five viaduct piers are carried up to an average height of 100 ft. above foundation level, and require an additional 15 ft. to complete them. On the south side the average height of the nine piers is 94 ft. above the foundation, and they require an addition of 53 ft. The cantilever end piers are completed to the same height as the viaduct piers. On the north side the whole superstructure of the approach viaduct, 840 ft. long, and weighing 1000 tons, has been raised in one length by hydraulic power, and now rests on the top of the viaduct piers. On the south side the length of the superstructure is 1520 ft., and weighs 1800 tons, and it in like manner rests on the top of the piers. The difficult and unprecedented work of erecting the great 1700 ft. spans has proceeded throughout with certainty and safety, and is being rapidly continued at three points, North Queensferry, Inchgarvie, and South Queensferry. The weight of the steel work now erected is nearly 12,000 tons. About 15,000 tons of girders, tubes, and bracings are ready to erect, and the total quantity of steel plates and bars delivered to the works up to the present date is 35,000 tons. The manufacture of the steel work is proceeding at the rate of about 130 tons per month. During the past few months the number of men employed has averaged 3000, and except from stress of weather, the work has proceeded uninterruptedly.

Royal Scottish Society of Arts.—The fifth meeting for the session of this Society was held in Edinburgh on Monday evening, under the presidency of Mr. D. B. Peebles. An improved military sketching protractor was exhibited and described by Major H. L. Mackenzie, R.A. Subsequently, Mr. John Miller Turnbull exhibited an apparatus for making gas from mineral oil by a continuous process. The method, he held, would be very suitable for the production of gas for the lighting of railway trains, steamboats, and other vessels, and for gas engines for tramway cars, &c. There was nothing novel, he said, in the production of gas from mineral oil, the subject having been before the Society in various forms; but this appplication of it, so far as he was aware, had not hitherto been dealt with. The oil is held in a reservoir above the retort, whence it is conveyed by a small pipe. In the retort it finds its way over small pieces of firebrick, pumice stone, or asbestos, at a red heat, and is quickly decomposed into gas. The oil may also be put into the retort in the form of spray by a small pump worked by the engine, or in the case of trains, by the carriage axle. The gas, manufactured in this way, Mr. Turnbull said, could be produced at about the same price as coal gas, namely, from 3s. 6d. to 4s. per 1000 ft.; but as gas from mineral oil had twice the candle power of the coal gas at present used in Edinburgh, the actual cost would be about 2s. per 1000 ft. Dr. Wm. Galt Black read a paper on perpendicular ventilation, which he illustrated by a model of a house with flues in action.

Institution of Civil Engineers.—A meeting of the Glasgow Association of Students of the "Institution" was held last Thursday evening, when an interesting lecture on "The Early History of Railways" was delivered by Mr. C. P. Hogg, M. Inst. C.E.

Another New Steel Works.—Messrs. Archibald Baird and Son, Glasgow, are about to erect at Hamilton a works for the manufacture of crucible steel in bars, forgings, and castings.

Renfrew Steel Works: A Correction.—The capital of the Renfrew Steel Company, mentioned in last week's "Notes," is to be 25,000*l.*, and not 250,000*l.*, as there stated.

MISCELLANEA.

THE Rev. Dr. Dallinger has been again re-elected President of the Royal Microscopical Society. He delivered his inaugural address last week.

At the Motala Works the engines are being constructed for three gunboats building at Sebastopol, while a fourth is being built and engined at Copenhagen.

The Right Hon. G. Sclater-Booth, M.P., has accepted the Presidentship of the Congress of the Sanitary Institute of Great Britain to be held at Bolton in September next.

At Bolton, the manager of the Rosehill Colliery was fined 5*l.* for not providing efficient ventilation, and permitting naked lights, whereby an explosion occurred in which several men were injured.

The directors of the Telegraph Construction and Maintenance Company (Limited) propose paying a dividend of 15 per cent. in addition to the 5 per cent. already paid, making 20 per cent. for the year 1886.

The directors of the India-Rubber, Gutta-Percha, and Telegraph Works Company (Limited), in their report for the year ending December 31, recommend a dividend of 1*l.* per share, making, with the interim dividend, a total for the year of 15 per cent.

Two balloons ordered by the Chinese Government have just left Marseilles for Tientsin, accompanied by a French aëronaut, who is to teach the Chinese officers how to manage them. One balloon is 6000 cubic metres in volume and the other 3000 cubic metres.

At the adjourned half-yearly meeting of the Manchester Ship Canal Company, Sir J. C. Lee presiding, the following new directors were unanimously elected: Lord Egerton of Tatton, Mr. Houldsworth, M.P., Mr. J. H. Bythell, Mr. C. Galloway, and Mr. C. Moseley.

It is hoped that a return, showing the number, description, cost, &c., of the various iron and steel guns supplied by the War Department to the Army and Navy respectively from 1855-6 to 1885-6, will be laid upon the table of the House of Commons within the present month.

The City of London and Southwark Subway Company seek power to extend their authorised subway from the Elephant and Castle to Kennington and Stockwell, and to acquire additional lands in the City at the south-east corner of Arthur-street east and King William-street.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended February 6, amounted, on 15,388¾ miles, to 1,092,387*l.*, and for the corresponding period of 1886, on 15,257 miles, to 1,064,022*l.*, an increase of 131¾ miles, or 0.8 per cent., and an increase of 28,365*l.*, or 2.6 per cent.

We learn from a diagram published by T. B. Rowe and Co., Brentford, that the price of town tallow was lower during 1886 than it has ever been since 1752. In the latter year it went down to 25s. 6d., but in the past twelve months it has been down to 24s. 9d. The highest price on record, 120s., was in 1808.

At a meeting of the Association of Birmingham students of the Institution of Civil Engineers, held at the Colonnade Hotel, Birmingham, on Thursday, the 10th of February, a paper prepared by Mr. Joseph S. Pickering, Stud. Inst. C.E., on "The Sewerage of Towns," was read. The President of the Association, Mr. Pritchard, M. Inst. C.E., occupied the chair.

Messrs. Woodhouse and Rawson, 11, Queen Victoria-street, have issued an illustrated price list of the thousand and one electrical appliances which they sell. This volume enables an engineer not experienced in electrical matters to form a fair idea of the cost of an installation, and to choose the fittings best suited to his purpose or to the architectural features of the building he is employed upon.

Recent returns show that the natives of India are by far the largest sufferers from railway accidents. The total number of persons, including passengers, servants, and others, as well as suicides, who lost their lives last quarter, was 104, as compared with 96 in the corresponding quarter of the previous year, and of those injured 202 as against 230. No fewer than 95 passengers met their deaths in carriages and at stations from causes unconnected with the working of the trains.

Lord G. Hamilton has stated in the House that of the appointments specified last year for the assistance of the Director of Dockyards, one constructor, one assistant-constructor, and one engineer assistant have been filled up. This leaves four more appointments to be made if the original scheme is adhered to, but it is probable that with the experience gained during the past year some modification may be advantageously made.

According to a German technical journal, experiments have recently been made at the artillery range near Cummersdorf with a new kind of mortar and a new explosive warranted to hold its own with General Boulanger's melinite. This explosive was used against a fortification constructed as exactly as possible on the model of one of the French frontier forts called Fort d'Arrêt, and in forty-eight hours it was "blown completely from the ground."

On Friday evening, February 11, Professor Ryan delivered a lecture on "The Life-History of an Engine," in the hall of the Athenæum, Bristol, to a large audience. The lecture was illustrated by models of engines constructed at the University College, Bristol, some of which were driven by steam on the lecture table. Amongst others was a Savary engine constructed of glass which lifted water into an overhead receiver, and a glass model illustrating Watts' invention of the condenser.

Last week the official trial took place of the first of two special class torpedo boats which have been designed and constructed for the Imperial Ottoman Government by Mr. G. F. G. des Vignes and Messrs. Maudslay, Sons, and Field, who conjointly carried out this work. These vessels are 126 ft. long and 15 ft. beam, and are fitted with three-cylinder compound engines. Satisfactory runs were made at the measured mile at Long Reach. The mean speed of the runs was 21.7 knots. The highest speed reached was 23.4 knots.

In the discussion on the Tehuantepec Ship Railway Bill in the United States Senate, Senator Morgan said, referring to our proposal to fortify islands in Panama Bay, that such an act amounted to a notice of England's purpose to command the Panama end of the canal; while on the east side of the Isthmus it had a similarly strong position in Jamaica. He hoped that the American people would say to England, "Whatever it is essential for us to have in the way of transit across the Isthmus, we are entitled to, and that we will have."

In a Foreign Office paper just issued, Mr. Thomas, vice-consul at Santiago, gives some reasons for the decline of British trade with Chili and suggestions for remedying the evil. Mr. Thomas thinks the decline of British trade during the past twelve years is principally attributed to the British manufacturers themselves, who confine themselves to producing articles dearer yet not so well adapted to the requirements of the country as American, German, and French products of the same class. In fact, British manufacturers, as a general rule, refuse and even fear to produce articles of ordinary use of inferior quality irrespective of markets; but the great mass of consumers all over the world, being the poorer and uneducated classes, ignore this fact, and only purchase what is cheapest, irrespective of nationality or quality. British manufacturers must therefore decide to make special goods for given markets or run the risk of being driven out altogether.

The *South Australian Register* says that a step which promises to affect the federation of Australia, is being taken by an English syndicate. Mr. J. R. Browne, who is the engineer of the syndicate, informs us that an offer has been made to the Western Australian Government to construct a railway line on the land-grant system from York, which is 100 miles east of Perth, to Eucla, a distance of 700 miles due west. If the Western Australian Government decide to accept the offer of the syndicate to construct the line on the 3 ft. 6 in. gauge, the company will receive alternate blocks of land amounting to 12,000 acres to the mile of frontage on the railway. If the work is undertaken an offer will be made to the South Australian Government to construct the line a further distance of 500 miles from Eucla to Port Augusta on the land-grant or any other system. The syndicate would expend 6,000,000*l.*, and direct communication by rail would be established between Perth and Brisbane—Adelaide, Melbourne, and Sydney being embraced *en route*. At the proposed rate of travelling the through journey from Adelaide to Sydney would occupy four days.

During January last the iron and steel exports from Great Britain reached the value of 220,050*l.*, as compared with 114,484*l.* for January, 1886, and 161,321*l.* for January, 1885. Pig-iron has been exported to the value of 149,377*l.*, against 135,003*l.* for the corresponding month of 1886. The greatest increase is shown by Italy, the value sent there having advanced from 10,711*l.* to 23,924*l.* In steel rails the value exported last month was 214,262*l.*, against 110,215*l.* for January, 1886. The United States, with which market no business was done in January, 1886, took rails amounting to 63,650*l.* last month; British East Indies advanced from 34,674*l.* to 57,036*l.*; and Australasia from 20,744*l.* to 40,183*l.* A gratifying feature of the steel rail trade is the reappearance of the British possessions in South Africa, which took steel rails to the amount of 7777*l.* last month, against *nil* for January, 1886. Brazil fell from 16,012*l.* to 2375*l.*, and the Argentine Republic from 24,811*l.* to 5766*l.* In steel (unwrought) the increased business shown last December is more than maintained. The value exported in January, 1887, was 136,284*l.*, against 73,083*l.* for January, 1886. To the United States was sent a value of 78,262*l.*, against 22,545*l.* in January, 1886.

VIADUCT OVER THE RIVER RETIRO, BRAZIL.

MR. JORGE R. GRÜNEWALD, ENGINEER

(*For Description, see Page* 155.)

Fig. 4.

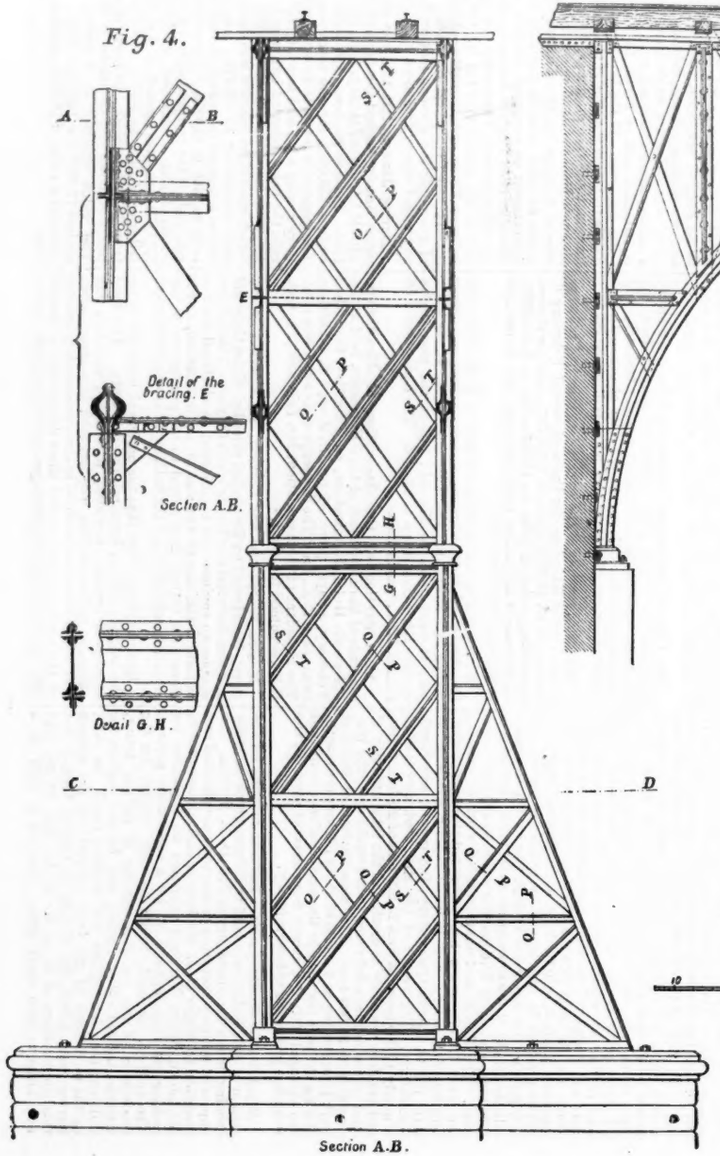
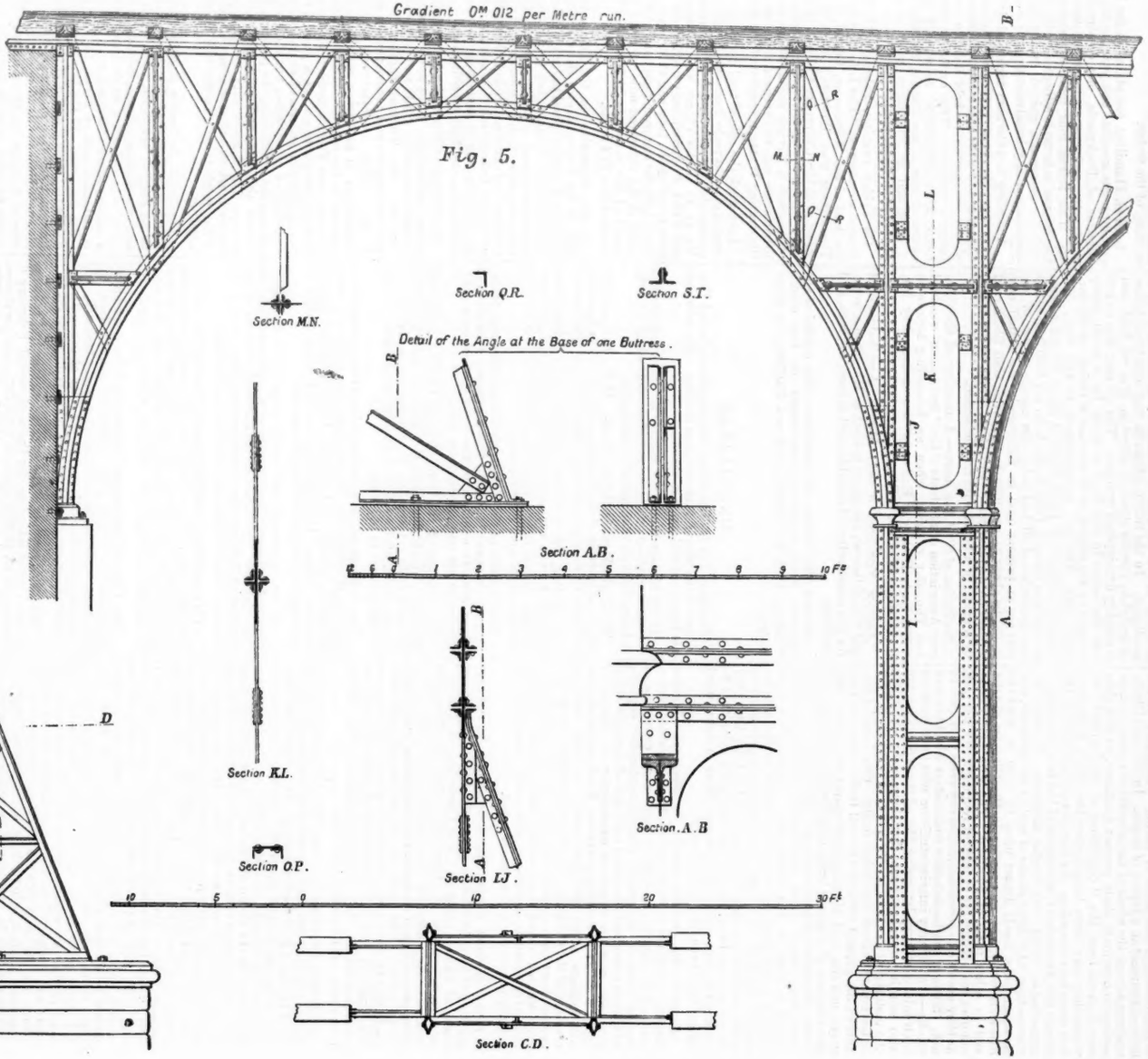


Fig. 5.



TRIPLE-EXPANSION ENGINES OF

CONSTRUCTED BY MESSRS. KINCA

(*For Descript*

Fig. 1.

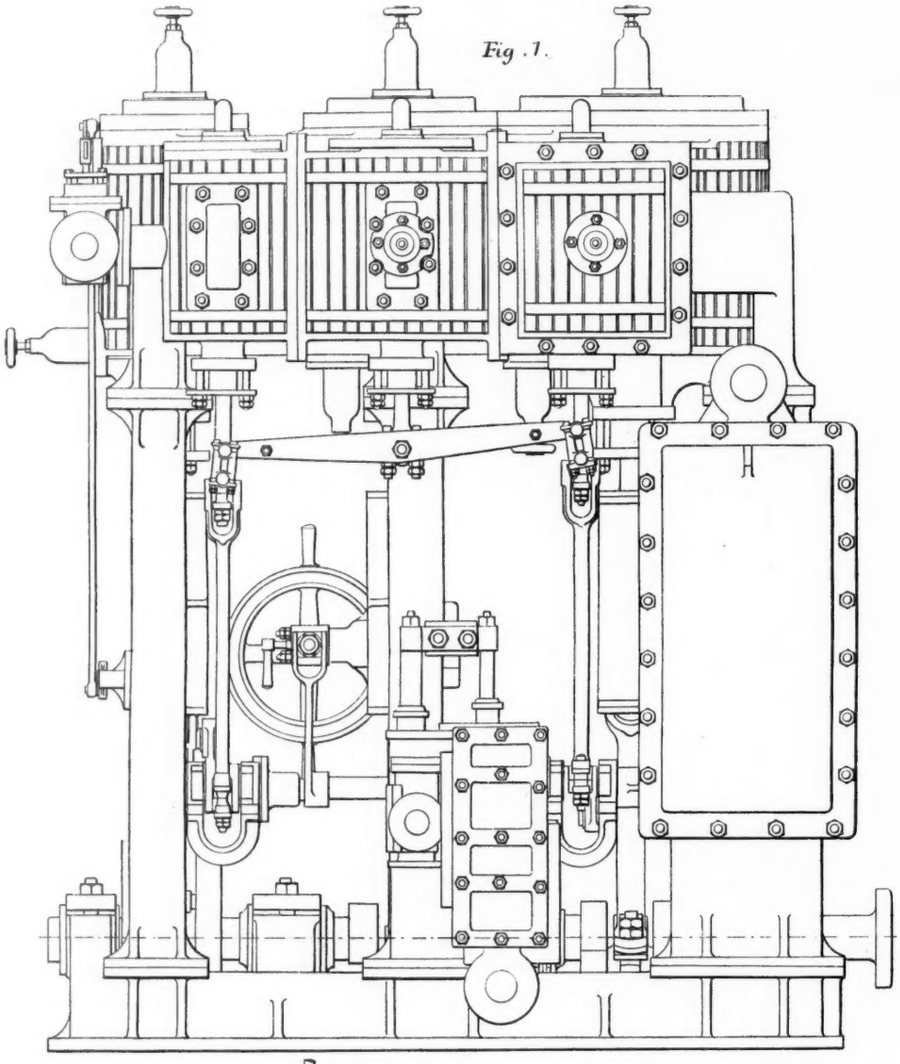
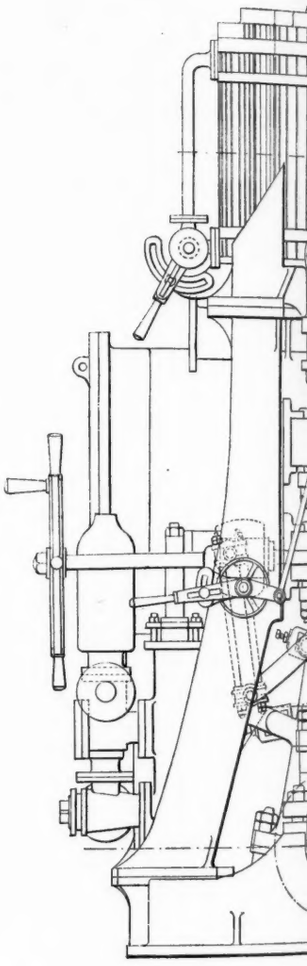


Fig. 2



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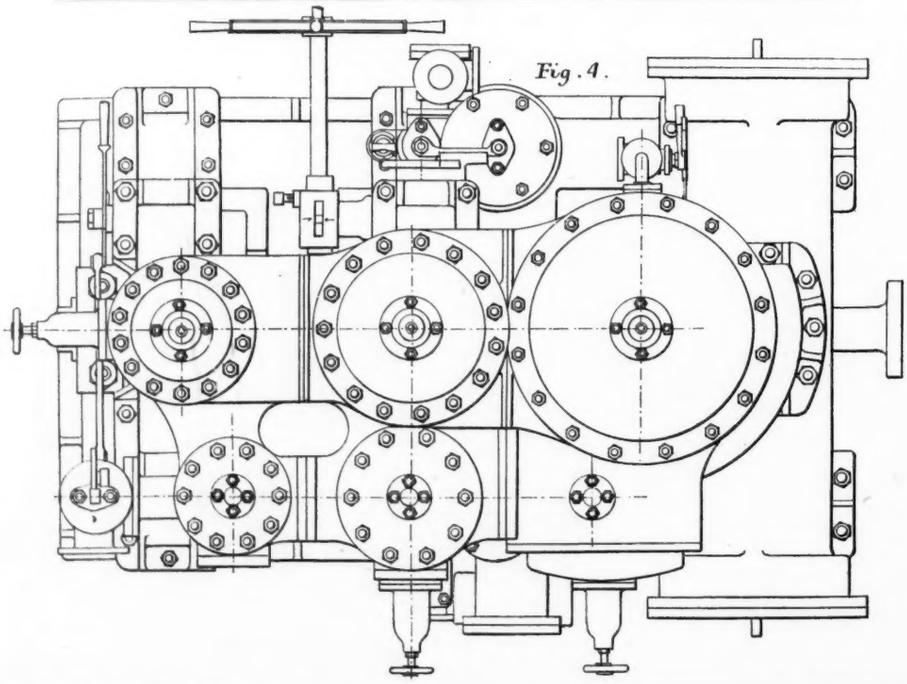
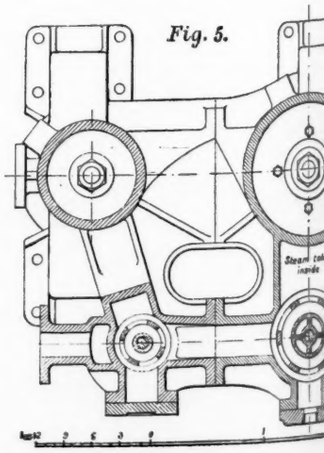


Fig. 5.

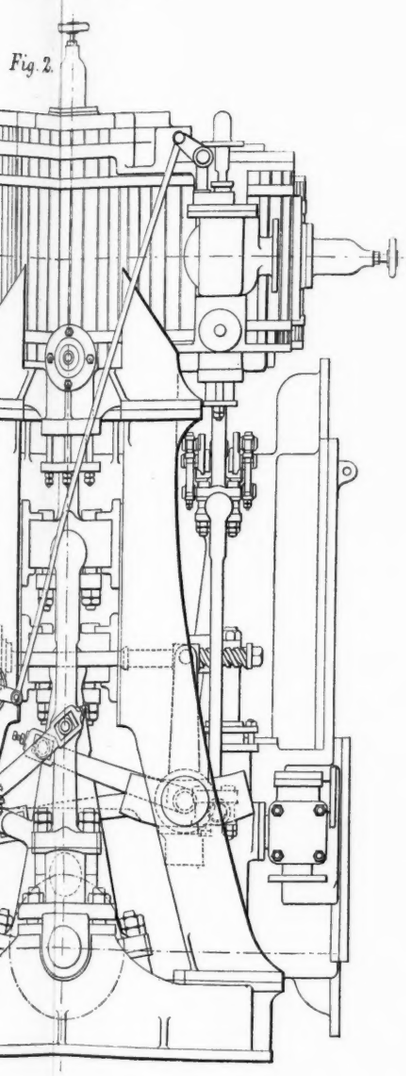


OF THE STEAM YACHT "CASSANDRA."

INCAID AND CO., ENGINEERS, GREENOCK.

(For Description, see Page 153.)

Fig. 2.



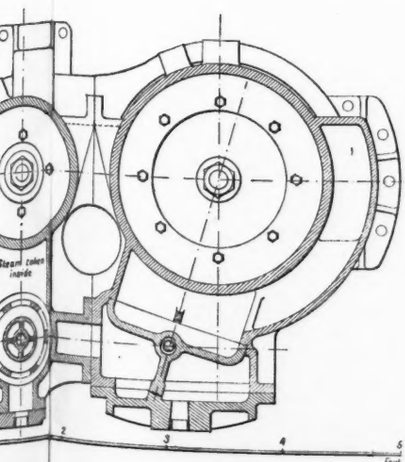


Fig. 3.

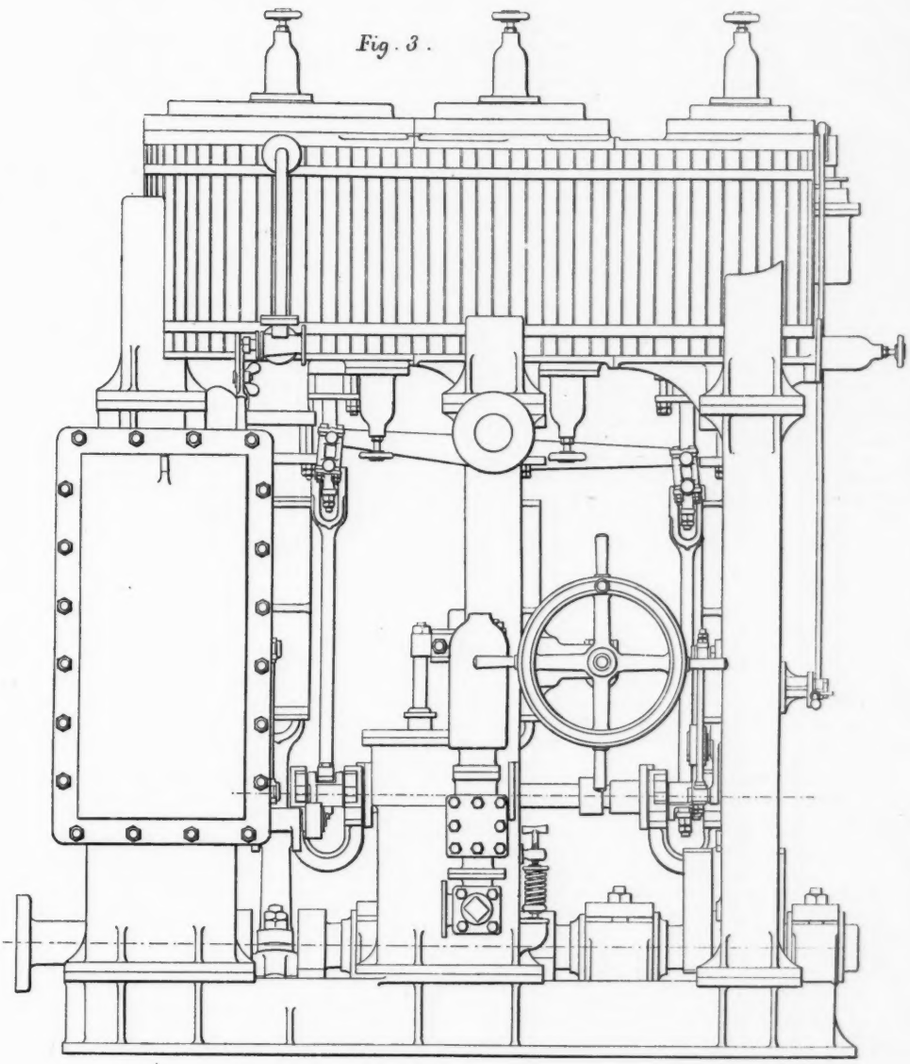
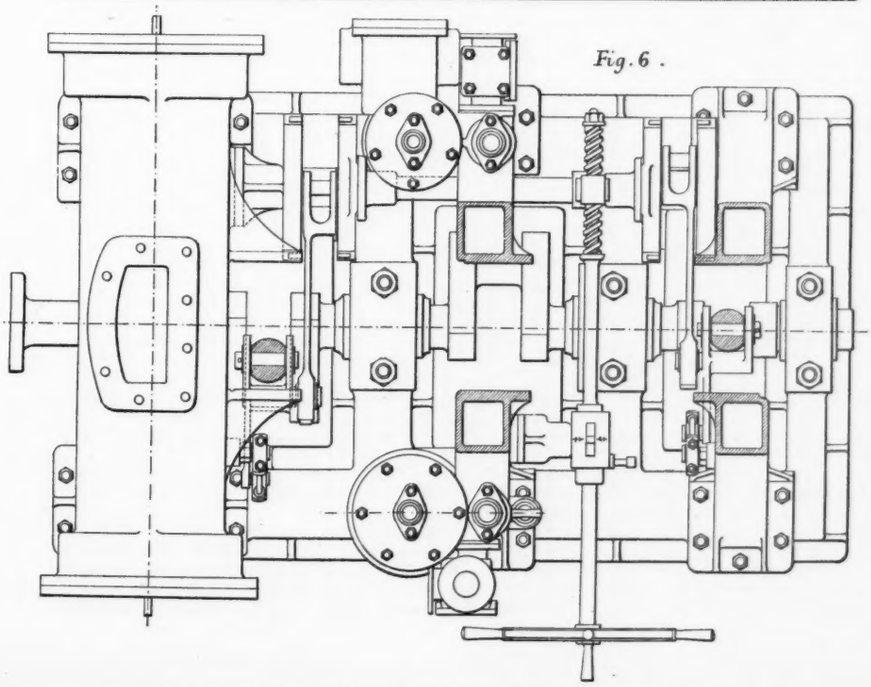


Fig. 6.



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With a Two-Page Engraving of TRIPLE-EXPANSION ENGINES OF THE STEAM YACHT "CASSANDRA."

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Students' meeting, Friday, February 18th, at 7.30 p.m. Paper to be read: "Diving; the Apparatus used, and the Work carried out under Water," by Geo. A. Becks, Stud. Inst. C.E.—Ordinary meeting, Tuesday, February 22nd, at 8 p.m. Paper to be read with a view to discussion: "Irrigation in Lower Egypt," by Wm. Willcocks, Assoc. M. Inst. C.E.

PHYSICAL SOCIETY.—February 26th, 3 p.m. Note on Professor Carey Foster's Method of Measuring the Mutual Induction of Two Coils, by Mr. James Swinburne.

THE SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Meeting at the Institution of Civil Engineers, 25, Great George-street, S.W., Thursday, February 24th, at 8 p.m. "Telephonic Investigations," by Professor S. P. Thompson, B.A., D.Sc., Member. Conclusion of discussion.

SOCIETY OF ARCHITECTS.—Tuesday, February 22nd, at 7 o'clock p.m., at the Freemasons' Tavern, Great Queen-street, W.C., when a paper will be read by Mr. J. J. Lish, Vice-President (Newcastle-on-Tyne), entitled "Smoke Abatement."

ENGINEERING.

FRIDAY, FEBRUARY 18, 1887.

THE PUBLIC SERVICES IN AUSTRALIA.

ONE phase of the all-pervading political influences which so injuriously affect the Government services in our Australian colonies is forcibly illustrated by a case recently referred to by Sir Henry Parkes, then leader of the opposition in the Legislative Assembly of New South Wales, and now Premier of the colony, at a public meeting at Paramatta, near Sydney. As the case referred to specially relates to the Public Works Department it seems to us deserving of notice.

The reference to the subject was *à propos* of the deficit of over 2,000,000*l.* in the revenue of the colony, to meet which the late Government of Sir Patrick Jennings had found it necessary, amongst other remedies, to attempt some retrenchment in the public service. The statement made by Sir Henry Parkes, as reported in the *Sydney Daily Telegraph*, was as follows: "Since Parliament was prorogued he had heard, through the newspapers, that notable efforts were to be made to limit the civil service of the country. Mr. Neild, M.P., had just told them that while these provisions for decreasing the number of civil servants were being made, persons had within the last few days been employed because they were connections of the ministers. Surely every one of his audience would admit that if of necessity you must reduce the civil servants in the country you could not at the same time favour persons by employing them. Because, surely, no man who had served the country for some time to the satisfaction of those placed over him should be dismissed to make room for a favourite and an untried man. He would give them one illustration of what had been done, and he spoke from facts within his own knowledge. In order to make a pretence of limiting the number of civil servants the Government had discharged a number of poor men who had no friends—railway men and the like. Now, mark what had taken place at the same time. We had a very high officer in the public service of this country, the engineer-in-chief for railways, Mr. John Whitton. He was really a very eminent man of very high character, and above all things he was a most conscientious and upright man. He was the builder of the whole of the railway system of the colony. Every mile of railway we had—beyond the first line from Sydney to Paramatta—had been projected and built under Mr. Whitton's superintendence. In consequence of the work of several railway surveys being completed, and there being a call throughout the service for heads of departments to effect reductions, Mr. Whitton proposed that thirteen railway surveyors, who had completed their work, should be dismissed, or rather that their services should be dispensed with at the end of this year (1886) simply because their work was done. But these gentlemen all had friends. He supposed they were all earning their 300*l.* a year upwards. The minister who represented the Government, gave directions that these men should not be removed for the present; all the time remember, he was dismissing these unfortunate railway men who had no friends at all. And there was a minute in existence, he believed, indeed he had no doubt about it, by Mr. Whitton, asking the minister how he was to employ these surveyors, seeing that there would be no work for them in January. Was not this evidence of the imbecility, or something else, in the Government carrying on this work of retrenchment in the civil service? Nobody wanted those servants dismissed, but if their work was done and there was no further work for them to do, surely that was one way in which the public money might be saved. And if their dismissal was resisted by the minister, who could know nothing about the service compared with the engineer-in-chief, while, on the other hand, he was dismissing men who had no friends to look after them, it seemed to him that there must be something at the bottom of these proceedings other than an honest desire to serve the public."

This case illustrates very fully the depth and thoroughness of the political thraldom in which some of our colonial civil services are sunk, and to which we alluded as long ago as 1884, in an article under the title of "The Australian Colonies as a Field for Engineers" (*vide* ENGINEERING, vol. xxxvii., pages 83 and 115). In the case alluded to by Sir Henry Parkes, the unfortunate men without "friends" were dismissed, it appears, without ceremony, under cover of efforts to limit the civil service of the colony, while new men were actually being employed "because they were connections of the ministers." Such inconsistency as this on the part of the Government, while extremely unfair to those whose services are dispensed with, cannot fail to create on the part of the employés in general a feeling of distrust highly prejudicial to the public service.

But another feature is exemplified in this case, to which we specially desire to draw attention. It is the element of personality given to these matters in the colonial public services. We allude to the minister's action in the case of the railway surveyors in its relation to the head of the department. Before entering upon this point, we may remark that, so far as the surveyors themselves are concerned, no one can, of course, help feeling sympathy for those whose services have to be dispensed with by reason of the completion of the work for which they were employed. The fact that the railway surveyors on the Government staff of New South Wales and other of our Australian colonies are engaged on a temporary footing, and are not on the list of permanent civil servants, whereby the Government is enabled to exercise the right of removing them without incurring liability for disturbance from office, does not lessen, but rather increases the misfortune of those whose services are no longer required. But to recur to the minister's action in its relation to the head of the department. The engineer-in-chief for railways appears on the occasion in question, in the exercise of his office and in the simple fulfilment of his duty, to have recommended that, in consequence of the completion of their work, the services of a number of surveyors should be dispensed with. In place, however, of this proposal meeting with the support of the Government, the minister then at the head of the Public Works Department seems to have given directions, apparently because these surveyors had friends in power, that the recommendation should not be given effect to, notwithstanding that provision was then being made, as has been noted, for decreasing the number of the civil servants, and that the Government was, as Sir Henry Parkes remarked, actually "dismissing those unfortunate railway men who had no friends." Now there can be no question that action such as this on the part of ministers, places the heads of departments in an entirely false position in relation to those under them. It transforms into a personal matter between the head of the department and the employés whose services it is proposed to dispense with what ought to be studiously treated by the minister as a purely abstract question, and not as an occasion for making political capital either for himself or the Government by ostentatiously throwing the shield of protection round employés possessed of political influence. It is possible that in this particular instance the minister was conscious of the approaching downfall of the Government, and wished to leave to his successor the invidious, though obvious, duty of assenting to the removal—notwithstanding the fact of their having "friends at court"—of those employés whose services were no longer required in the public interest. The minister's action appears, however, to have been none the less wanting in proper consideration either for the interests of the community at large, or for what was due to the head of the department, who, in advising the reduction, was not only doing his duty, but was, in fact, as Sir Henry Parkes remarked, responding to a "call throughout the service for heads of departments to effect reductions," and who ought on that account alone to have been supported in the recommendation he made.

Perhaps one of the most important, though invidious duties thrown upon the heads of departments in the service of Australian Governments is that of resisting the pressure not only of members of Parliament but of ministers themselves to find employment for their numerous protegés. Yet, notwithstanding this, if the head of a department failed to recommend reductions in his staff when the completion of the work rendered it necessary, these very ministers and members of Parliament would, when occasion arose, be the very first to turn round on the head of the department and throw upon him unmeasured censure. The censure would, doubt-

less be deserved, because the head of a department would be unworthy of his position who had not the moral courage to recommend the removal of those whose employment was no longer necessary. But men of honour and self-respect, fitted for the position of heads of departments, and especially the Department of Public Works, cannot fail to fight shy of service under those colonial governments where they are liable to be placed in the invidious position instanced in the case to which we have referred. The consequence must inevitably be a deterioration in the class of men who fill these important positions. Yet, without men of honour and self-respect at their head, these departments cannot but become more than ever the prey of political jobbery at the expense of the communities, and to the discredit of the colonies concerned.

THE 110-TON (ELSWICK) GUN.

For some months past visitors to the Royal Arsenal, Woolwich, may have noticed, lying near the great steam crane of the Gun Factories, two large guns, within a fraction of 44 ft. in length, and each weighing 247,795 lb., or rather over 110½ tons. One of these pieces of ordnance—the largest ever made in this country—last week commenced its firing trials at the proof butts, under the personal supervision of Colonel Maitland, R.A., Superindent Royal Gun Factories, and in the presence of the president and some of the members of the Ordnance Committee; Captain Andrew Noble, C.B., and Mr. Vavasseur represented the Elswick Ordnance Company.

We shall in an early issue give illustrations of the new gun, and shall compare it with the 119-ton Krupp gun, but meanwhile we may give some leading particulars. The gun is made throughout of steel; the "A" or inner tube is made in one length from a forging supplied by Sir J. Whitworth and Co., instead of being in two parts, as in the Italian heavy guns, made also at Elswick. Over the inner tube is shrunk the breech-piece, which is supported by three layers of comparatively thin steel hoops. It will thus be seen that the whole of the metal assists in bearing the transverse strain, but the inner tube is free from any portion of the longitudinal strain, as it extends only to the "obturator;" the breech-piece takes the greatest part of that strain, but it is assisted therein by the peculiar construction and distribution of the hoops. A long hoop with stout shoulders forms the rear part of the first layer, and its front exterior shoulder engages the rear shoulder of another long hoop, which forms the front part of the second layer. Again, the "trunnion hoop" (so called) is formed and shrunk on in such a manner as to draw the long hoops of the first and second layers together; hence there is a direct pull from the trunnion hoop to the shoulder on the breech-piece. There are in reality no trunnions, the exterior of the trunnion hoop forming rings which will be held in a strong steel band attached to the gun slide in the barbette battery of the ship. To prevent the inner tube moving forward inside the breech-piece, a ring of a bronze alloy is run into a serrated recess at the front of the latter; a similar ring is used to assist friction in keeping the front of the trunnion hoop in its place.

The hoops are all so arranged as to break joint, and an ingenious plan is adopted to link together, by means of the outer one, those hoops which abut against one another. This consists of rings on the exterior and interior of the inner and outer hoops respectively, alternate portions of which rings are slotted away; the outer hoop, when heated, is passed over the inner, so that the projections left pass through the slotted intervals, and it is then turned round till the projections of one hoop engage exactly with those of the other. No longitudinal movement is now possible, and the intervals are all filled up with steel wedges, so that there can be no circumferential shift. Thus the gun is bound together from the extreme breech end to a point far up the chase.

It may be noted that, in the French heavy guns, the breech-screw engages in the inner tube itself, which thus becomes almost wholly responsible for the longitudinal strain. Again, in Krupp's great 119-ton gun, the longitudinal strain is entirely taken by the end of the breech-piece, which supports the back of the wedge closing the bore; it is moreover weakened by the loading hole through its rear end.

The "obturation," or means of stopping the escape of powder gas, is peculiar to this gun. It is not the Elswick cup nor the De Bange asbestos pad, but a modification introduced by Mr. Vavasseur, wherein the mushroom-head of the De Bange pad is retained, but the asbestos is replaced by a ring of soft copper which is forced by compression, on the discharge of the gun, into close contact with the inner tube; no ring is required to be inserted inside the end of the bore.

The principal dimensions of the 110-ton gun are as follows:

Total length	524 in.
Length of bore (30 calibres) ...	487 ,,
,, rifling	397 ,,
Diameter of bore	16.25 ,,
,, chamber	21.125 ,,
Cubical capacity of chamber ...	28,610 cub. in.
Weight of gun	247,795 lb.
,, projectile	1800 lb.

The polygroove rifling commences with one turn in 120 calibres and increases to one turn in 56 calibres at the muzzle.

The gun was carried down to the proof ground, as well as fired upon, the ingenious bogie carriage—running on six pairs of steel trucks—constructed in the Royal Carriage Department under General Close, the steel castings being supplied by Messrs. John Rogerson and Sons, Stanners Close Works, Wolsingham. It weighs 95 tons, and is so constructed that it can be altered to mount for proof all the heavy breechloading guns from the 12 in. of 43 tons upwards. The carriage is free to run back on the inclined rails, when fired, returning again to the loading point by its own weight; but the chief force of recoil is taken by the Vavasseur hydraulic buffers, the ends of the pistons being fixed on the carriage, while the cylinders are free to move with the gun slide.

It was about noon before the firing commenced, the service of the gun being very slow owing to the operations of loading, &c., which will ultimately be performed with the greatest ease by means of hydraulic gear, having at present to be carried out with ordinary tackle by hand. The charges of powder commenced at 600 lb. of Waltham Abbey "prism brown," commonly called "cocoa" powder; each charge was subdivided into sections of about 112 lb. or 150 lb. for convenience of loading, the prisms being arranged as usual in rigid hexagonal cartridges cased in silk cloth. The proof cylinders weigh 1800 lb., as will the service projectiles, all of which will be made of steel; the armour-piercing projectile will be of forged steel, probably made on the Firminy plan, the others being common shell and shrapnel. The report of the gun was not so loud as might have been expected—owing, probably, to the slow-burning powder used, and the length of the bore, but the addition of each 100 lb. of powder made a very appreciable difference in this respect.

The recoil of the hydraulic cylinders on the slide at the first round was about 4 ft., in addition to which the gun and carriage ran back on the inclined rails from 50 ft. to 60 ft.; in the second and third rounds the recoils on the slide were 4 ft. 9 in. and 5 ft. 6 in., and the distances travelled back on the rails 69 ft. and 77 ft. respectively. The fourth round (which was fired on Wednesday last) was fired with 850 lb. of Westphalian powder, "Prismatic No. 1 Brown," the prisms measuring 1¼ in. from face to face and 1 in. in length. The explosion proved to be quick and sent the powder pressure up to 18¾ tons, or 2¾ tons higher than was anticipated. The highest service pressure is intended to be 17 tons, so that this has already been exceeded in the trials. The muzzle velocity was not increased in proportion to the pressure and only reached 2078 ft. per second. The recoil of the gun on its carriage was 3 ft. 3 in., the hydraulic buffer being set to a greater resistance than before, and the run on the rails was about 70 ft.

The corrected muzzle velocities and the mean pressures in powder chamber are given in Table A, together with the total energy at muzzle, and the energy per ton of gun—the latter proportion being a very important consideration in naval ordnance.

On the first day only one round had been fired before the men's dinner-hour, and the gun was not loaded for the second time until 3 P.M.; owing to the accurate observations which had to be taken after each shot, as well as to the slowness of manipulating such masses of metal by hand, it was nearly 5 o'clock before the firing was suspended for the day. Upon careful examination at the end of the three rounds the interior of the inner tube was found to be perfectly clean and uninjured.

It is intended to continue the experimental proof of this gun with successive charges of 900 lb., 925 lb., and 950 lb., or such of them as can be fired until the intended limit of pressure in the powder chamber is reached. It is hoped that a muzzle energy bordering upon 62,000 foot-tons may be attained with the full charge. The powder charge of 850 lb. was the largest ever hitherto fired from a gun in this country, although the Elswick 104-ton gun for the Italian Government was fired at Spezzia with some 50 lb. more; the projectiles were virtually of the same weight, but the muzzle velocity then attained was only 11 ft. per second higher than that given by the third round of the 110-ton gun with 100 lb. less powder.

Table A.—*Showing Results of Firing 110-Ton E. O. C. Gun.*

No. of Round.	Weight of Powder Charge.	Weight of Projectile.	Muzzle Velocity.	Mean Pressures.	Total Energy at Muzzle.	Energy per Ton of Weight of Gun.
	lb.	lb.	feet per second	tons per sq. in.	ft.-tons	ft.-tons
1	600	1800	1699	9·65	36,050	328
2	700	1800	1843	12.05	42,390	385
3	800	1800	2007	15.00	50,260	457
4	850	1800	2078	18.75	53,927	490

Note.—Round No. 3 would give a power of perforating about 30 in. of iron at 1000 yards' distance.

The following are the comparative results (so far as they are known) given by the heaviest guns in the possession of the chief European naval powers, with those already obtained from the 110-ton gun.

Table B.

Nature of Gun and Calibre.	Weight of Gun.	Powder Charge.	Weight of Projectile.	Muzzle Velocity.	Total Muzzle Energy.	Perforation of Iron at 1000 Yards.	Energy per Ton of Gun.
	tons	lb.	lb.	feet per second	foot tons	in.	foot tons
French, 37 cm. (14.56 in.)	71	546	1180	1955	31,272	24.5	440
German (Krupp), 40 cm. (15.75 in.) ..	71	485	1715	1703	34,502	23.8	486
Ditto ditto ..	119	615	1632	2017	46,061	29.2	387
Italian (Elswick), 43 cm. (17.00 in.) ..	104	899½	1799	2018	50,810	29.5	488
English (R.G.F), 13.5 in.	67*	625	1250	2050	36,415	28.6	569
,, (Elswick) 16.25 in.	110	850	1800	2078	53,927	33.0	490

* The results of this gun are estimated only.

Note.—The Russian and Austrian guns are on the Krupp system, but less powerful than those given above.

The above Table shows the very favourable performance of the newest English gun as compared with the Krupp. The length of bore in the former is very nearly as great as in the latter, the extra length over all being necessitated by the projecting breech-piece of the Krupp system, which also accounts for a great part of the additional weight. It is to be noted, however, that the largest charge of powder hitherto fired (so far as we are aware) in the Krupp 119-ton gun is a very light one compared with that which has been fired already in the Elswick guns; also, that the heavy German gun has been ordered by the Italian Government for coast defence. We are indebted to Lord Brassey's "Naval Annual" for most of the above figures concerning foreign guns.

GUNBOATS.

The unknown and generally overrated powers of offence of the fish torpedo have given that weapon a character as an engine of destruction which recent experiments have not borne out. The silent and treacherous manner in which it would deliver its attack, together with the diabolical and complete nature of the destruction wrought, have invested it in men's minds with imaginary powers of destruction little less than supernatural. As a consequence the more honest and outspoken assaults of artillery have by comparison suffered in reputation for efficiency; but in the science of destruction, as in other walks of life, honesty is found to be, in the long run, the best policy, and the blow below the belt is not so favourably looked on as it was some short time ago.

Under these circumstances Sir George Elliot has chosen his time well, for advocating the more extended use of gunboats in coast-defence tactics; for although the torpedo had never wrested from the gun its premier position, so far as large vessels were concerned, it has had things very nearly all its own way with the smaller kind of craft. The paper which the gallant

admiral read at the Royal United Service Institution last Friday had the serious defect of wandering very far from the subject matter of its title. It would perhaps be too much to expect Sir George Elliot to discourse for any length of time about ships without fighting over again the battle of the Waterwitch and the question of hydraulic propulsion. But although one may be willing to grant him the indulgence of this amiable weakness, it is taking rather a wide range to discuss our own naval policy, both from a political and economic point of view, under cover of "Gunboats for Coast Defence."

Having said this we have little but praise for the paper in question, and although the greater part of it was not germane to its title, yet the strictures of the author on political meddling in naval matters might well be read by every one of Her Majesty's subjects; more especially all those close-fisted and short-sighted tax-payers who grudge the expense of our national insurance, the chief premiums of which are the ships of the Royal Navy.

We must not, however, be led astray by the author's bad example, but will at once proceed to consider some of the most important facts respecting coast defence by gunboats, as set forth in the paper.

The author commenced by speaking of the notable services rendered by gunboats in past times, referring to James's "Naval History," and then puts the question "whether modern inventions have in any degree affected the essential value of this class of vessel for coast defence, either by the introduction of steam, armour plating, submarine mining, rifled guns of greatly increased calibre, or quick-firing or machine guns, by the substitution of vessels of the Glatton type, by torpedo boats of various types and dimensions, or by a combination of all or any of these appliances for purposes of inshore defensive operations?" The gallant admiral at once proceeds to answer his own question in the negative. "I am unable to perceive," he says, "that the modern gunboat has been supplanted by any of these novel features, or has lost any of its effective power for warding off attacks by bombardment at long ranges, whether by single ships or small squadrons; and, in fact, whatever advantages have been obtained on the one side, are equally applicable to the other." Indeed Sir George goes further than this, for he says later on: "It would appear that owing to the reduced number of guns which modern ships now carry, and the long ranges at which the stoutest ships are now penetrable by guns which can be mounted in gunboats, and with the introduction of the latest invention of shell projectiles, that the gunboat of the future has rather gained than lost."

Armour-clad ships may be less vulnerable than the old wooden vessels, but the same remark applies, as the author pointed out, to shield-protected gunboats fighting end-on, and the smaller object will still retain its distinct advantages. Sir George Elliot would not, however, wish to disparage the value of shore batteries, submarine mines, or torpedo boats, but thinks that these means of defence would prove inoperative in the absence of assistance from gunboats, so far at least as preventing the bombardment of many of our seaport towns from distances of four to five miles.

The question, like all others of national defence, is based on expenditure. How to get most for our money is what must guide our decisions. This the author fully recognises, and upholds his position chiefly on the score of economy. It has been contended that an outlay on additional warships, equal to that demanded for gunboats stationed round the coast, would give a more efficient means of protection. This opinion, Sir George acknowledges, presents itself with a certain amount of force at first sight, but even if true in some respects, there is always the fatal objection that powerful seagoing ships might be enticed away, and they would not possess the advantages, for inshore fighting, of shallow draught. Sir Andrew Clark advocates seagoing torpedo vessels, very swift, but completely unprotected and lightly armed. In spite of the lower cost of such craft compared to armoured gun-boats, Sir George Elliot stands by the latter, because the vulnerable torpedo vessels could be disabled in detail by gunfire, as a ship at sea would naturally turn her stern to approaching torpedo boats, and keep them under fire as long as possible, and when ships are moving in the same direction, the striking range of the torpedo is almost reduced to close quarters.

The author advocated two classes of gunboats for the purposes under discussion. The first class should possess considerable speed, and would be designed to take the place of vessels of the Glatton type; whilst the second class would be for purely local defence where a high rate of speed would not be essential. Both classes should be armed with one very powerful armour-piercing gun, protected by a semicircular shield of stout armour plating for end-on fighting, besides carrying a number of quick-firing and machine guns for defence against torpedo boats. The first class should have two military masts. The smaller vessels, roughly of about 800 tons displacement, would work in close vicinity to the land, and would not require a speed above 12 knots. Their tactics would be to advance a few thousand yards from the shore and always retire if pursued. The larger class would be about double the size and mount a 12-in. breechloader 43-ton gun. They would be stationed at different ports ready to concentrate at any point threatened. The vessels would operate as widely as safety would permit, so as to operate if possible from opposite directions of fire, and thus obtain a broadside attack.

The problem of manning such craft led to some remarks on the naval volunteer question; but without following the author and other naval officers, who spoke afterwards, it may be sufficient to say that this body has evidently won the high esteem of the regular service by the efficiency and zeal they have displayed under somewhat discouraging conditions, due principally to want of an adequate chance of learning their duties.

The discussion which followed the paper was not worthy of the occasion or the Institution. The subject is so essential a one for the service, that one might have hoped naval officers would have attended in order to give their views and help those who have the settling of such matters to form an opinion as to the soundness of the author's contentions. As a matter of fact there was little if anything said of a critical nature so far as the ostensible object of the meeting was concerned; the old dreary controversy on hydraulic propulsion, with all the stock arguments hashed up afresh, occupying the greater part of the time. The one bright feature in the discussion was the admirable manner in which the chairman, Admiral Sir E. Fanshawe, carried out his duties.

CONTINUOUS BRAKES.

IN the House of Lords on the 14th inst. Earl De La Warr asked whether it was the intention of Her Majesty's Government to take any steps this session relative to the question of railway brakes, especially with regard to enforcing the conditions which are considered essential by the Board of Trade to constitute an efficient brake. His lordship went through the oft-told story, showing the powerlessness of the Board of Trade, and the amount of attention which the moral pressure it had brought to bear for ten years had received. The London and North-Western Railway Company was instanced as one of the principal obstructives, who are now fitting their stock with a brake which did not comply with the Board of Trade conditions, and which was peculiar to itself and one small company in connection with it. Earl de la Warr said there was sometimes an appeal *ad misericordiam* on behalf of the railway companies as regards the expense of continuous automatic brakes, but in connection with this Mr. Laing, the chairman of the London, Brighton, and South Coast Railway Company, had recently told his shareholders as follows:

"I may say that in my judgment the increased safety in travelling is due very much to the general application of those precautions—namely, the block system, and the interlocking point signals, and the Westinghouse brake. These are the three great causes which have reduced the number of accidents on this and other lines so largely, and as I know some of our railway brethren are a little jealous of Board of Trade interference, I think I am bound to say the Board of Trade has done good service in urging those improvements upon railway companies. However, there is the result, and I may say it has been exceedingly satisfactory. If we take one case alone—the Westinghouse automatic brake—we had a return made some time ago, and the result was to show that a very large number of accidents, both to the public and still more to our own servants, had been averted entirely by having a brake that was able to stop trains in a very short time indeed. I think it has paid its expenses five times over in the money question, to say nothing of the humanity, in saving life."

Lord Stanley, of Preston, the President of the Board of Trade, said, in reply, that he was not prepared to say whether the Government should proceed by legislation or any other way to compel the railway companies to take action, but they would not fail to continue their moral pressure. As though to show the weakness of this reply, and to adorn the tale told by Earl De La Warr, the same paper in which it appeared contained an account of an accident on the Great Northern Railway on the 14th inst., which would have been prevented had an automatic brake been in use instead of the simple vacuum brake still affected by the Great Northern Company, in spite of the "moral pressure" of the Board of Trade. It seems that, as the north express was passing Werrington Junction, the slip portion in the rear became detached, and the mishap being observed by some platelayers, who waved a red flag to the driver, the latter quickly pulled up the train, and thereupon the slip portion ran into it with great violence, seriously injuring several passengers. Had such an incident occurred on, say, the Brighton Railway, both the front portion as well as the slip would have been promptly brought to a stand without collision.

The chairman of the London and North-Western Company has not allowed Earl De La Warr's strictures to pass unnoticed, for at the half-yearly meeting of shareholders on the 15th inst., Mr. Moon is reported to have delivered himself as follows: "If Lord De La Warr had done the company the honour of coming and asking them a question on the subject, he did not think his lordship would have made the statement which he did as to the North-Western Company; but as that statement had gone abroad it was only right that he (the chairman) should tell the meeting what they had done. The brake of which his lordship had spoken so disparagingly as only used by one railway, had been used for many years almost without a failure, and without the smallest complaint, and had worked admirably; but he (the chairman) had told the proprietors some time ago that, finding most of the large companies in their neighbourhood were using the vacuum brake, they had themselves determined to apply it, and that it would cost the company 110,000*l.* to do so. They had applied it, and had more than half of their stock fitted with it. In addition, in deference to the wishes of some of the neighbouring companies, they had also agreed to instruct their officers to make the brake automatic, and that they were doing at a cost of 45,000*l.* He would not, however, like them to run away with the idea that the continuous brake, which Lord De La Warr so strongly recommended, was to do away with all danger. On the contrary, it had its own special dangers. He (the chairman) was not in favour of it, but in deference to the general desire of the community and the wishes of the Board of Trade, they were adopting it."

Mr. Moon has told his shareholders many remarkable things about brakes, but it must be allowed that the above is about as remarkable as any previous statement he has made. "Almost without a failure and without the smallest complaint, and had worked admirably!" The records of the Board of Trade inspector's reports, as well as the brake returns, furnish hundreds of illustrations to the contrary; but there is, in addition, the further evidence with which Mr. Moon supplies us, viz., that in deference to the general desire of the community and the wishes of the Board of Trade, his company are about to turn their non-automatic vacuum into an automatic vacuum brake at a further cost of 45,000*l.* Considering the admirable nature of the appliance now undergoing alteration, we wonder the shareholders did not at once raise an objection to such a waste of money. But it may be that even the London and North-Western shareholders have grown incredulous of their chairman's statements, and remember that they are now fitting the third system of brake within a few years, and perhaps they have not forgotten, as it would appear Mr. Moon has, the runaway accident at Birmingham on the 5th of May last; the collision with the buffer stops at Sutton Coldfield on the same railway the day previous, and the collision at Carlisle on the morning of the 21st of December. The official report on the last-named accident has not yet been issued, but we believe it will be found that the failure was due to the vacuum brake pipe being choked with ice, and all three accidents, as well as that at Penistone, were caused

by the failure of the brakes which Mr. Moon still appears to prefer to the automatic arrangements recommended by the Board of Trade.

CEMENT TESTS.

The necessity for some recognised standard test for cement has often been adverted to amongst cement manufacturers, the diversity of specifications is a common cause of complaint. It might be said that the Metropolitan Board of Works specification is generally considered the standard for high-class cement, and indeed as Mr. Grant is one of the greatest authorities on the subject, it would be reasonable enough for engineers to adopt at any rate the leading features of the Metropolitan Board of Works specification. But the Board itself does not seem to have implicit faith in it, at any rate it is otherwise difficult to account for the usual requirements being altogether abandoned in the case of the new works at Barking, let the other day to Messrs. Mowlem. We should have thought that these works were as important, and require as good materials as any of the recent contracts of the Board, but we must be wrong, as a high-class cement does not seem to be wanted at Barking. The usual specification which is supposed to have been the results of Mr. Grant's labours and experiments for many years is known to most of our readers, but for the benefit of those who have not seen it we may recapitulate its leading features :

The whole of the cement to be pure ; not to set, neat, in less than one hour ; to be ground so fine that residue on a 5800 sieve shall not exceed 10 per cent. by weight ; to be cool when brought on to the works ; to be stored in a dry shed and spread on the floor. Specific gravity to be not less than 3.10, chemical analysis to be satisfactory. Five weeks' consumption always to be on the works.

Test.—To be gauged with three times its weight of dry sand (which has passed through a 400 and been retained on a 900 sieve) and 10 per cent. of water ; briquettes, 1 in. section, to remain 24 hours in a damp atmosphere and 27 days in water, and then to stand a tensile stress of 250 lb. per square inch applied at the rate of 200 lb. per minute.

Now this specification may be considered severe, but it is at any rate clear, and makers can perfectly understand what sort of an article they have to supply. Can this be said of the Barking specification? Here are its chief provisions : The whole of the cement to be best quality ; to be ground extremely fine ; to weigh not less than 112 lb. to the imperial (striked) bushel ; to be brought on to the works in a fit state for use and not to be used for three weeks thereafter.

Test.—To be gauged neat, immediately put into water, and after seven days to stand a stress of 225 lb. per square inch.

This specification seems to have been drawn up to be as little like the other as possible ; there is absolutely no similarity. A vague and general description may be suitable for small works, where it might perhaps be cheaper to provide for extra cement in the work than to go to the expense of carrying out vigorous tests ; but on large works it is difficult to excuse such an absence of definite terms. What is extremely fine? and how is the weighing to be done? No doubt such points will be settled satisfactorily by the engineer when the trial comes, but why not state them at the outset? And why are the usual requirements of the Board of Works—already printed and thoroughly well known to all cement makers—abandoned?

A vague specification is an injustice to the manufacturers, because so much being left to the caprice of the engineer in charge of the works, those makers who know his opinions and disposition are in possession of superior information, and enabled to base their prices accordingly. Indeed vague specifications are apt to be made the means of diverting contracts into favoured channels. We do not mean to hint that there is anything of that sort in the present case, but Cæsar's wife ought to be above suspicion, and the abandonment of the well-known Metropolitan Board of Works specification does look odd, to say the least of it.

NOTES.

Trials of Corn Drying Machines.

During the whole of the month of May of this year there will be at Milan an international competitive exhibition of machines for drying Indian corn and rice. There will be two prizes of 80*l.* each for the two classes of machines, and in addition the Minister of Agriculture will purchase the machines which have gained the prizes. The commission will provide all that is necessary for the experiments, and the exhibitors can obtain special terms of transport from the railway and steamship companies, both for their goods and servants. In case machines are at work in other parts of Italy and cannot be sent to the exhibition, a commission will go to see them, and will submit them to the determined tests without removal. In all cases preference will be given to machines which do not destroy the germinating power of the seeds. Application for admission to the contest must be made before March 31, to the Minister of Agriculture, Industry, and Commerce, at Rome.

The Electric Light through a Fog.

It was recently announced that the electric light on May Island, at the mouth of the Firth of Forth, had been sighted in clear weather from a distance of forty-six miles at sea, by the master of the Swedish steamer Frithiof. The same steamer arrived at Granton last Friday, and the master of the vessel reports that early in the morning of that day, when there was a very dense fog prevailing, he had got within three miles of the May Island before the very powerful electric light recently placed in the lighthouse could be observed, and that it then only resembled a dim light from a single candle. These two facts afford a very marked contrast in regard to the penetrative power of the electric light in clear weather and in a dense fog. It is well that such data should be put on record and accumulated for future reference.

Telegraphing without Wires.

Professor Dolbear, the well-known American electrician, has succeeded in telegraphing without wires by causing a series of electrical discharges to pass into the earth without discharging into it the other terminal of the battery or induction apparatus used. Suppose the positive pole of an induction coil be "earthed" one hundred times a second, then the ground there would have its potential raised one hundred times per second. At a distant point let the negative pole of a similar coil be earthed one hundred times a second ; it follows that between these two points there will be a greater difference of potential than at surrounding points, and a current will flow between them one hundred times a second. The telephone is used to interpret these currents, which are interrupted by a Morse key, and the humming sound caused in the telephone by the vibratory current is broken into long and short signals or dots and dashes. The plan is adopted for telegraphing between vessels at sea, and indeed is similar to that recently tried by Professor Graham Bell in Boston Harbour. Professor Dolbear described his plan in 1883, but it can hardly be called novel.

A Perspective Microscope.

At a recent meeting of the Royal Society, Mr. G. J. Burch read a paper "On a Perspective Microscope," which he had invented. In 1874 he discovered that when two lenses are separated by a distance equal to the sum of their focal lengths, the optical conditions are such that the magnitude of the image bears a constant ratio to that of the object, no matter where it is situated upon the optic axis. This ratio is that of the focal lengths of the two lenses. A displacement of the object along the axis causes a displacement of the image in the same direction, but in the square of the ratio. Further, he found, that a picture drawn with the camera lucida under these conditions has the perspective of an object magnified in the square of the ratio, when it is brought within the proper distance of the eye. He has constructed a perspective microscope on these principles. The field of view is small, but may be increased by using more than two lenses, and Mr. Burch is of opinion from his results that with glasses of wide angle specially constructed, a high power with a sufficiently large field might be obtained. At the Royal Society meeting Mr. Burch exhibited his instrument with a piece of moss under it, which was shown in magnified perspective.

Electric Headlight for Ships.

The navigation of the Suez Canal at night by aid of the electric light demonstrates that this method of illumination might be advantageously applied in other situations where hitherto vessels have not dared to move after dark. In other straits and channels, where the traffic is not sufficiently large to pay for the proper lighting and buoying of the banks and coast, an electric headlight would enable a vessel to pick her way with safety, all objects for a thousand yards before her being made distinctly visible. An electric plant designed for this purpose was exhibited last week at the works of Mr. Peter Brotherhood. It consists of a three cylinder engine and a Victoria Bush dynamo built on one bed-plate, and an automatic arc lamp of very simple and strong construction fixed in a projection fitted with a parabolic reflector and a horizontal dispersion lens. The beam from a current of 30 ampères is spread out into a band, which widens as it goes, until at a distance of 1000 yards, it stretches over a width of 300 ft. The lantern can be tilted or turned from side to side as desired, and if it be desired to minutely examine any object in the distance the dispersion lens can be turned aside, and the condensed conical ray from the parabolic reflector, be directed on to it. The plant has been designed to occupy as little space as possible, the engine and dynamo only measuring 4 ft. 7½ in. by 1 ft. 9½ in. by 1 ft. 9 in., and can be placed in unskilled hands.

A Monastic Fleet of Steamers.

According to a Russian newspaper an engineer from the White Sea has just arrived at Motala, in Sweden, to take over a steamer that is being built for the monks of Solovetsk. This vessel will make the sixth steamer belonging to the monks, who use them to convey to their monastery the 30,000 pilgrims that annually repair to the place. The monastery is situated on the largest of the three islands forming the Solovetsk group. The island measures fifteen miles in length by ten in breadth, and is only accessible from the middle of May until the middle of September. During this period steamers owned by the monks run regularly to Archangel and back, charging very little for the double voyage, and in the case of very poor pilgrims, nothing at all. Each pilgrim, moreover, according to ancient custom, is boarded and lodged for nothing at an inn belonging to the monastery. Besides its shrine, Solovetsk is famous for its mines of talc, large quantities of which are exported to Russia and abroad. A peculiar feature about the Solovetsk steamers is that they are all manned by monks, and commanded by monastic captains. The mainmast of each steamer is surmounted by a golden cross. In the time of Peter the Great the walls of the monastery were defended by ninety cannon, and during a rebellion against the Government, sustained a siege of two years. During the Crimean War the monks claim to have driven off the English fleet by firing some of the old cannon remaining, and marching in procession round the monastery walls. Although the fleet owned by the monks does not pay expenses, the offerings of the pilgrims make up for the loss, the monastery being one of the wealthiest in Russia. At present the number of monks exceeds 200.

The Steno-Telegraph.

The steno-telegraph results from the combination of the mechanical stenograph and the telegraph. To the former it owes the recording of a considerable number of words in a unit time ; to the latter the possibility of transmitting this number of words and printing them at a distance. The signs printed are on short horizontal lines, each line representing a word, and these signals are automatically transmitted. M. G. A. Cassagnes has recently brought out a steno-telegraph consisting of a transmitting apparatus comprising a receiver key, an automatic transmitter, and a distributor, while at the receiving station there is a receptor identical with the distributor, polarised relays equal in number to the keys of the perforator, and a "printer." Similar to the Wheatstone automatic perforator in its effects, the perforator of M. Cassagnes perforates holes representing syllables, not merely letters, as in the Wheatstone. The distributor is similar to that employed in the Meyer and Baudot multiple telegraph. As to the speed of sending, 400 words per minute can be transmitted on lines up to 350 kilometres long ; that is to say, 24,000 words per hour with two keys. On lines of 650 kilometres 280 words per minute, or 16,000 to 17,000 words per hour ; and on lines of 900 kilometres 200 words per minute or 12,000 words per hour. The steno-telegraph permits of a speech being transmitted as it is delivered. For example, a speech commenced in Paris at 2 P.M. could be set in type at Marseilles ten minutes later, and that

without a relay, and by a single wire. In short, the speech could be circulated at Marseilles as quickly as at Paris, although these cities are 863 kilometres apart. Probably no existing telegraph operated by only two keys affords this rapidity of transmission. Operators require about six months to telegraph at the rate of 150 to 200 words per minute; and the printed record can be read after fifteen days' practice. In an early issue we hope to illustrate and fully describe one form of the steno-telegraph.

THE BRIDGE ACROSS THE HUDSON RIVER AT POUGHKEEPSIE, U.S.

Although most of the inland commerce to New York, the metropolis of the United States, moves by way of the valley of the Hudson, and all of the inland commerce of the New England States crosses this river, yet it is unspanned by any bridge for 150 miles from its mouth. Work has begun in good earnest for a railway bridge at Poughkeepsie, 75 miles from New York, at a point whose position in regard to railroads will render the structure a great factor in commercial relations of these States, for it will supply a link completing a direct line to the coalfields of Pennsylvania, and reduce the cost of transportation of coal to those States 75 cents (say three shillings) per ton. But it is rather with its engineering features than as a factor in industrial economy that it concerns the reader. This bridge will be built by the Union Bridge Company, of Buffalo, and will be almost the longest cantilever bridge in the world; it will consist of five spans over the water, three of them being cantilever spans of 550 ft. each, and two trusses each of 520 ft. span; the whole length of the bridge, including the viaduct approaches, will amount to two miles. It will be a double-track bridge made of steel, and capable of supporting a moving load of 3000 lb. per lineal foot on each track, or expressed with more realism, it will sustain moving freight trains, each drawn by 85-ton locomotives on each track. The builders have bought 7000 tons of the 11,000 tons of steel required for this bridge in England, and it is stated that the first intention was to buy the whole in this country. In fact, American contractors build bridges in Australia made from English steel, although when such manufactured bridgework is exported, the United States Government gives a rebate of 90 per cent. of the customs duties levied upon the importation of the steel. It is estimated that this bridge will serve for the transit of 1000 loaded freight cars per day; and eleven different railway lines can reach the approaches by construction of short lines of railway, in no instance exceeding twenty miles. The cost of the bridge is estimated at 4,000,000 dols.

COAL IN THE CRIMEA.

According to a Russian official journal, recent investigations, while demonstrating that coal does exist in the Crimea, have not proved that it can be found in large quantities, or that the quality is as good as could be desired. If one remembers that during the last Turkish war the people of Odessa suffered severely from a fuel famine, and cruisers could not stir from Sebastopol for want of coal, it is easy to understand that the question of developing the coal supply of the Crimea is one of very great importance for Russia. It is true that since 1878 things have very much improved, the coalfields of the Donetz region having been largely developed and connected with the southern parts by new lines of railway. The distance between the two, however, is still inconveniently great, and in the event of war the single-line railways would have their energies fully taxed in conveying to the coast troops and stores alone. On this account, when a few months ago indications of coal were discovered on the banks of the River Alma, close to Sebastopol, the event excited a good deal of rejoicing on the part of the Russian press. The *Journal of the Minister of Finance* now announces that the discovery was like the discoveries in Solomon's time—simply the recollection of things forgotten. So long ago as 1838 Verneille, in a geological work on the Crimea, referred to the existence of coal near Sudak. Four years later, Hue, the French traveller, spoke of coal being extracted and used on an estate at Mukhalata. In 1867, Romanovsky described some coal deposits he had found near Balaclava, Sudak, and the Odosia. Ten years later M. Favre confirmed the existence of lignite near Balaclava, while in 1881 Gospodin Davidoff declared the coal deposits of the Crimea to be of the most extensive character. More recent researches testify to the existence of coal nine miles from Simpheropol in seams 12 ft. thick, and exceeding in quantity "a milliard of poods;" but doubts have been cast on this assertion. Altogether, it would appear that although a number of independent observers, foreign as well as Russian, have indicated the existence of coal in many parts of the Crimea, no regular survey has yet been taken in hand. The *Journal of the Minister of Finance* thinks that the time is now ripe to do this, and seeing the importance of the subject there is very little doubt that the suggestion will be adopted before long, particularly as Russia is so anxious to render her fleet independent of English fuel.

THE PROSPECTS OF THE IRON TRADE.

The ultimate prospects of the iron trade do not present themselves in bright colours as seen in the annual report of Messrs. Bolling and Lowe, of 2, Lawrence Pountney-hill, E.C. As for the present, they consider that no decline in prices will take place for some time to come, and that buyers can gain nothing by waiting. But when they turn to the future they point out that nearly all foreign countries have adopted protective tariffs, and that those of Russia and Austria have been increased of late. India, our best customer, still continues to send us large orders for her railways, but a time must come when her cheap labour will attract capital to render available her stores of iron and coal, and when that event arrives, the example of the Bombay cotton mills appears to assure success to the native effort and a considerable reduction of our exports to that market. The Canadian demand for railway iron is falling off, but the rapid colonisation of the country may be expected to open up a market for manufactured hardware. The Chinese railways are still in the clouds, while the Japanese trade, which is promising to increase, is threatened with the imposition of duties. The average net earnings of British railways declined again last year, falling from 4*l.* 3s. 2½d. per cent. to 4*l.* 0s. 5d. per cent.; the exports fell from 296,967,583*l.* to 270,934,935*l.*, while the imports decreased from 390,018,569*l.* to 373,834,314*l.*, the excess of imports over exports rising from 93,000,000*l.* to 103,000,000*l.* This excess is more than double that of France, and more than thirty times that of Germany, while in the United States the exports exceed the imports by 34,304,679*l.* Still, with all our difficulties, our trade exceeds that of France and Germany combined, and there are some bright prospects to set against our difficulties. In 1886 the United States took from us nearly one-fourth of our whole iron and steel exports, the amount being 796,626 tons, against 397,668 tons in 1885, and the values being 5,592,561*l.* and 4,106,109*l.* respectively in the two years. Spain now gives us the benefit of the most favoured nation clause; trade is improving in South Africa, and in many of the countries of South America. Prices of iron have risen, while the steel makers are fully occupied, and are likely to be so for some time. The report ends with a recommendation that, when money is asked for new undertakings in the colonies and abroad, the lenders should insist on its being spent in England, and that all should strive to find new markets for our manufactures.

COAL IN TEXAS.—A fine coal bed has been discovered at Strawn, 80 miles west of Fort Worth. Professor Jewett, of St. Louis, has examined the coal, and his analysis shows it to be superior to McAllister coal. The Texas and Pacific Railroad Company is building a siding to the Strawn mine, and 60 miners now at work are to be increased to 400 when the track is laid and the coal can be brought to market. The railroad company has made a contract with the owners to use the coal. As Fort Worth pays 8 dols. per ton for coal at the present time, and cannot get as much as it needs even at that price, the value of the new mine can be fully appreciated. The Strawn vein is 38 in. thick, and underlies at least 7000 acres.

BATH AND WEST OF ENGLAND SOCIETY AND SOUTHERN COUNTIES ASSOCIATION.—This Society will this year hold its annual show at Dorchester on May 30, 31, June 1, 2, and 3, and money prizes amounting to upwards of 2500*l.*, which is a considerable increase upon previous years, are offered for horses, cattle, sheep, pigs, poultry, cheese, butter, cream, &c. The display of implements, machinery, and articles of general utility is always a very large one, and among other attractive features will be exhibitions of paintings, art manufactures, flowers, fruit, &c. The butter-making contests, which were such an interesting feature of the Society's show at Bristol last year, will be again carried out on a considerably extended scale. Regulations, &c., can be obtained of the secretary, Mr. Thomas F. Plowman, Bath.

DISSOCIATION IN THE STEEL FURNACE.

TO THE EDITOR OF ENGINEERING.

SIR,—I am glad Mr. Frederick Siemens confirms my estimate of the value of M. Michael Berthelot's investigations relating to gaseous explosive mixtures. The student of physics is indebted to the illustrious French Minister of Education for his splendid contributions to the science of thermo-dynamics and thermo-chemistry.

It is interesting to find that the law of increase of specific heats of gases with increase of temperature, is not incompatible with thermic and empiric laws hitherto established. It has been demonstrated by MM. Mallard and Le Chatelier that the molecular specific heats of simple gases formed without condensation, and equal at low temperatures, continue to be equal at the highest temperatures.

If Mr. Siemens will take Berthelot's specific heats of the products of gaseous combustion in a steel furnace at a steel melting heat (whether the complete action of combustion in an interval of time allows for an intermediary period of incandescence of the carbon atoms before their complete oxidation to CO_2, or whether the combustion is complete *instanter* is immaterial) and calculate the attainable temperature, I think he will find that the products of combustion absorb so much heat, as to preclude the possibility of a temperature of dissociation being attained, but when the combustion is in a cold cylinder, the improbability of obtaining the presumable temperature of dissociation becomes still more apparent.

In the experiments on attenuated combustion I referred to in my letter, the air supply was reduced by lessening the area of the air supply valve, and combustion became more and more attenuated as the reduction was increased. The furnace was not of the Siemens recuperative type.

Respecting the theory of the shortening of flames in recuperative lamps, I may say that I had the pleasure of seeing Mr. Siemens' ingenious lamp at the meeting of the Iron and Steel Institute, and heard his explanation of its construction.

If Mr. Siemens will test the supply of air (anemometrically) flowing to the point of combustion when the lamp is cold, and afterwards when hot, I think he will find there is a very considerable increase, and if he could reduce this supply, when the flame has become reduced to its minimum length, so as to be equal to that when cold, he would, I think, find that the flame would become longer. I shall, however, gladly accept Mr. Siemens' invitation to test the lamp when an opportunity occurs.

Traversing Mr. Siemens' reply to Mr. Crowe, I am pleased to see his explanation of the wearing away of the furnace ports, which confirms my theory of kinetic effect (or the molecular movement of the gases) producing erosive or abrasive action—wearing away the walls of the furnace ports; a theory neither so improbable nor so abstruse as that of dissociation in the steel furnace advanced by Mr. Crowe.

The statement made by Mr. Crowe, that a flame has a higher temperature than the products of combustion, is rather an indefinite expression, because flame is simply the solid and carbon portion of combustion heated to incandescence by the *products of combustion* of the hydrogen from which the carbon is liberated on the oxidation of the former; on the oxidation of the latter to CO_2, an additional thermic equivalent is added to the thermic value of the combustion of the hydrogen, so that theoretically the outer fringe of a flame should be its hottest part, and this fringe is the product of combustion.

It may, however, be stated that, in a certain interval of time, if a solid and highly refractory body be placed in the zone of the complete oxidation of both the *hydrogen* and the *carbon*, and if this body has a lower specific heat than the products of combustion, it will attain a temperature higher than that of the products of combustion in proportion to the difference between the specific heats of the gases and the solids. The incandescent gas burner is an example of this kind.

I think Mr. Crowe will, when he has carefully examined Berthelot and Vieilles' investigations, admit that they fairly deserve the application of the term, exhaustive and conclusive, and that in face of established coefficients of specific heats at high temperatures, he will see that the assumptions in his letter are untenable. Mr. Crowe states than explosive mixtures attain only one-half of their theoretical temperatures; will he kindly explain how this theoretical temperature has been arrived at, and whether the specific heats were those given by recent experiments or not? I should assume not.

I am glad that it is admitted that the increase of specific heat may play a part in the action of explosives. I go further and venture that the specific heat theory may explain a great part of the phenomena of the combustion of gaseous explosive mixtures.

The synthesis of the adiabatic curve is not affected by the specific heat theory, and I am not aware that either our great countryman, Clerk-Maxwell, or that distinguished mathematician M. Fourier, has accepted the dissociation theory.

The maximum heat of combustion in a cylinder is of course at that part where complete oxidation is effected, and near the point of ignition, and might possibly be at a distance of 3 in. in the assumed experimental fireclay tube, the increased length of visible combustion when the cylinder has become highly heated might be due to the increased kinetic energy of the gases, due to decreased loss of thermic energy by radiation, owing to tube being hot.

Mr. Crowe states that it is certain that the "flame" diminishes in temperature as combustion proceeds. Is this correct in its application to the combustion of gaseous explosive mixtures?

In a gas engine cylinder, combustion, with a perfect explosive mixture, quite free from inert gases, is almost in-

stantaneous; for in a mixture composed of $2\,CO+O_2$, the duration of time which elapsed between the moment of ignition and that of the production of the maximum pressure was 12.86 thousandths of a second.

In this period the diagram of an ordinary explosive mixture would, in an ordinary gas motor cylinder indicate, say, eight atmospheres, the absorption of the remaining heat by the compound gases, of the products of combustion on the specific heat theory, limits the range of increase of temperature, the remaining thermo-dynamic energy is imparted by the release of the sensible heat of the gases resulting from combustion. I think if Mr. Crowe will examine the question—after divesting himself of the dissociation theory—he will see that the suggested specific heat theory is worthy of acceptance, as an explanation, in a great measure, of the phenomena of the action of oxidisable gases when oxidised or burnt in a gas motor cylinder. He might also follow with some advantage Mallard et Le Chatelier in their "Recherches Expérimentales et Théoriques sur la Combustion des Mélanges Gazeaus Explosifs." ("Journal de Physique," 2e. Série, t. iv., p, 59 : 1885.)

Again, referring to Mr. Frederick Siemens' letter, as to the question of heat transference by direct contact of combustion *versus* that by radiant combustion, it appears to me that the former principle is with complete and necessarily non-luminous combustion and for concentrated effect by far the most effective; but for heating large surfaces and when applied to materials that are oxidisable, such as blooms, plates, bars, &c., direct contact and complete combustion produces great waste by the oxidisation of the materials, and is also much more destructive in its action on the furnace side walls.

Consequently, for heating and similar furnaces the principle of radiant heating is advantageous both by its reduction of waste of iron by oxidation, and by requiring less expenditure in furnace maintenance; besides, with proper recuperative arrangements, and a reduction of the temperature of the waste gases to the lowest limit compatible with a satisfactory chimney draught, this principle of heating should attain almost the full practically possible thermic efficiency according to Carnot's formulæ.

Again, with reference to the cause producing an attenuated flame. I still think the explanation given in my last letter, simple as it may be, is nevertheless the true one.

Yours faithfully,

B. H. Thwaite.

P.S.—For open-hearth steel-melting furnaces the advantage of heating by radiation will be confined to the reduced wear in the furnace roof. Direct contact heating assists by its oxidation the action of conversion or decarbonisaion.

To the Editor of Engineering.

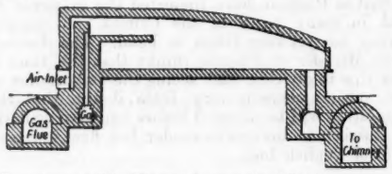
Sir,—Mr. Siemens, in his letter to you of the 25th ult., appears to say that in stating the temperature attained in a gas engine cylinder to be 1600 deg. Cent., and in referring to dissociation, I quoted Mr. Clerk, and mentioned page 27. I may say that I did not quote Mr. Clerk; neither did I mention any page or part of his book. Mr. Clerk does give the temperature as 1600 deg. Cent., but so do many others. I have also my own experience to go by. Mr. Clerk does state his views on the subject of dissociation, but they do not appear to be quite identical with mine.

Mr. Siemens says he has shown my views on dissociation to be erroneous. What he has done is simply to show that they differ from his own.

I certainly do believe that 2400 deg. Cent. is about the temperature of complete dissociation of steam at atmospheric pressure, as I know that an oxyhydrogen flame has about that temperature. Under considerable pressure—say 100 lb. per square inch—the temperature of complete dissociation would probably reach 4000 deg. Cent. It is for this reason that explosions in vessels give such varied results. In a gas engine cylinder 2400 deg. Cent. would be probably the temperature of dissociation, as the mixture is largely diluted with inert gases. I have burnt gases continuously in a chamber at from atmospheric pressure to 40 lb. per square inch, and find that pressure increases the temperature at which a flame burns enormously.

I should have mentioned in my last that in the experiments with the 3-in. tube, I caused the flame to burn both in contact with the tube and without, and found no difference in the length of the flames in the two cases, after the tube was a bright red heat.

I am pleased to see that Mr. Siemens admits the truth of my statement, that radiation increases in much greater ratio than increase in temperature, but I think Mr. Siemens is wrong in applying this as an advantage when heating by radiation in the steel furnace, because the temperature of the material to be heated approaches that of the flame, and all the advantage of the increase of radiation is lost, as it only applies to radiation between two substances of equally great difference in temperature; also, metals are the worst absorbents of radiant heat; on the other hand, silica is amongst the best. Heating by radiation may be all very well for chemical and glass furnaces, but it should be remembered that when heating by contact there is the advantage of also heating by radiation at the same time. I must say I fail to see how heating by contact can be more injurious to the furnace than heating by radiation, if in the former the same precaution is taken to prevent the flame touching the silica as in the latter, and there is not the slightest difficulty in doing so. I have seen many gas furnaces for heating plates on the radiation principle seven or eight years ago, and beg to inclose a sketch of one. It will be noticed that the roof is highest at the gas and air entrance, and that it slopes downwards towards the end at which the gases are led off to the chimney. In order to heat the plates equally it is also found necessary to protect that part of the plates which are under the beginning of the flame by an arch of brickwork, and to approach the flame to the plate at the other end; I consider that this proves Mr. Siemens to have been wrong when he stated that my remarks on the heat of different parts of a flame were diametrically opposed to facts.



In answer to Mr. Thwaite's remarks, Mr. Siemens says he has explained the matter referring to the shortening of the flame in his stove in his letter to you of the 25th ult., he simply said he agreed with me "that radiation from flame increases in a much higher ratio than its temperature," but he does not even touch upon what I stated as the reason for the flame shortening as it became hotter.

I consider it an open question as to whether a luminous flame radiates more heat than a non-luminous one; the only physical difference between them is that one gives off a minute portion of its heat as light rays, while the other gives the whole of its heat as heat rays, and the most powerful heat rays are those which are invisible. Platinum has been heated to incandescence by absolutely invisible heat rays.

Referring to the subject of the abrasive action of carbon particles, it will be noticed that in the plate heating furnace, the flame will touch the roof the full length of the furnace, yet the roof is not injured; the furnace is not regenerative and the flame is not hot enough to fuse ordinary fireclay. How is it the carbon particles do not destroy the roof?

I have never seen any data of the amount of coal used per ton of steel made in the radiation furnace and cannot judge of its economy in that respect.

Steel furnaces are as a rule stopped for repairs of some description every week end; and it is certainly wonderful for a furnace to work for twelve months without stopping for repairs; the chequer work is usually taken out and replaced every three or four months. Possibly the furnaces were stopped for other causes, and advantage taken of such stoppages for repairs. The only way is to give the cost of repairs per ton of steel made; the length of time without being stopped for repairs is vague.

Is there any other explanation than dissociation for the following facts? A perfectly mixed explosive mixture when injected through a gauze burning with a flame many times longer than it would be did the gases burn in the time of complete inflammation, such a flame becoming cooler as it burns, even although carefully protected from loss of heat, instead of accumulating heat and becoming hotter as it burns. I believe that the same flame which in the first instance was 18 in. long could be lengthened infinitely could it be surrounded by an absolutely perfect non-conductor.

Mr. Siemens says, "Mr. Crowe has missed the point of my argument which referred to repeating Bunsen's experiments in vessels of the same capacity but of different forms, and not in vessels of the same form but of different capacities." I would suppose that giving a vessel an irregular shape would have the same effect as diminishing its capacity, so far as the effect on the explosion went, as its cooling surface would be increased.

I have an idea that when Bunsen made successive explosions of the same mixture he used tubes about ½ in. in diameter, so that as soon as the gases reached dissociation temperature, the enormous proportion of cooling surface extinguised them, Bunsen was not able to obtain successive explosions in a larger vessel; a Bunsen burner cannot be larger than ⅝ in., otherwise it will ignite in the tube.

Yours truly,

Edward Crowe.

Grove Hill, Middlesbrough-on-Tees, February 8, 1887.

ENGLISH *v.* AMERICAN LOCOMOTIVES.

To the Editor of Engineering.

Sir,—Having taken special interest in reading the letters that have appeared from time to time in your paper on American *versus* English locomotives, I have been considerably amused at the idea of American makers being the only people that work on the duplicate system. I have no doubt, also, that many practical men have smiled to themselves and allowed the matter to pass on as so much American bunkum. Your correspondent last week hits the right nail on the head when he says that "American makers manufacture locomotives; English makers make them."

English makers have to make them to specification and to drawings supplied. The material must stand the most severe tests. Resident inspecting engineers are often appointed to see that the contract is minutely carried out, and in many cases when the work is finished and delivered the work has to be guaranteed for so many thousand miles. Many years ago English makers manufactured locomotives, and the different railway engineers selected those that took their fancy and suited the requirements of the railway from the different classes made by Sharp, Kitson, Stephenson, Hawthorn, Slaughter, or Tayleur, and other makers that were then in the field; but when Ramsbottom, McConnell, Kirtley, Beattie, Allan, Gooch, and other noted men struck out designs for themselves, a great alteration was caused in locomotive making. Now nearly all English and colonial engineers have their own designs of locomotives; also the Indian Government railways, so that English makers are compelled to make their work to order, and cannot go on making classes of locomotives on stock, as I understand Americans do.

In time, when American locomotive engineers begin to feel they can act on lines of their own design, same as Mr. Wooten, they will introduce new and complicated designs, and locomotive manufacturing will develop into locomotive making after the same manner as it has in this country. I remember very well when serving my time at Wolverton, if any of the locomotives that were being repaired in Haversham shed required any of the parts to replace broken ones, it was quite a common occurrence to get the said parts from engines in the shops undergoing repair, and these engines were made by nearly all the different makers that I have before mentioned, the big "bloomers" made by Sharp being especially noted for their changeability; and I have no doubt whatever that any of the aforesaid makers could supply duplicate parts made to drawings and templets of the engines made at that time, viz., 1857 to 1862, if required. As regards locomotives of the present day, they are made with mathematical accuracy and changeability of parts, and it is surprising your American correspondents don't know this. From what I can learn from those that have served their time under me and have been to America, the manufacturers there give their parts plenty of "play;" where we give, say, an easy, fit just a "feel," they give ⅛ in. This difference greatly assists the changing of parts. As for the getting up of valve faces, machines did this with the cylinders in their place at Wolverton twenty-five years ago, taking only a few hours.

I have always looked upon the American design of locomotives as a natural necessity. In the first instance, they adopted the Bury bar frame because they had no rolling mills to make plates, cast-iron wheels because of the difficulty of getting smiths to make wrought-iron ones, the use of wood for cabs and platforms because of the cost of thin plates; a bell and a big lamp I suppose the nature of the country requires. This design having got such a hold from the start, it will require a long time to alter the fashion; but if the Americans will take off the duty on English engines I have no doubt the American design of engine could be delivered in America as cheap and as good as they are made at home.

I should like to know what became of the American locomotive that came to the L. Y. Railway, Manchester, some few years ago; what caused its abrupt departure, and if it is still alive and doing well?

T. D.

Manchester, February 13, 1887.

To the Editor of Engineering.

Sir,—I question whether the letter in last week's Engineering by Mr. Smith, of Delaware, U.S.A., necessitates my troubling you. In any case it does not call for any lengthened notice at my hands, notwithstanding that I seem to have specially incurred Mr. Smith's displeasure, and that he soars to notice, if not to fame, on the smouldering remains of a demolished "Mr. Burnett." Permit me, however, to say a few words. I will compress my remarks as much as possible.

After the lapse of over ten months from its commencement, Mr. Smith discovers that there has been going on in your columns, as he says, "an extended discussion on the merits of American *v.* English locomotives," and forthwith makes an attack on a letter written by me on the subject as long ago as April 26, 1886. But Mr. Smith has evidently not taken time to read the correspondence carefully, and therefore falls into many errors.

For instance, he says, "In your issue of April 30, Mr. Burnett makes a comparison of what *he calls an American engine* and an English engine." If Mr. Smith had read the opening sentence of my letter to which he refers, or the one published in the issue preceding, he would have seen that I did not select for comparison the American engine in question, *i.e.*, "No. 169," but that it was rather thrust upon me as a notable example of an American engine by your correspondent "Cleveland," who after sounding its praises asked, "Can any Enlglish locomotive give an equal result?" But the question, *Who* selected the engine (No. 169)? is of little consequence. The fact remains that I was able to give an English engine—the "Gladstone" engine—that in all crucial and essential points not only equalled but beat hollow "No. 169." The *beating* being unquestionable, the only way out of the difficulty for our American friends is to repudiate the engine. Mr. Smith accordingly gets up at the eleventh hour, or rather at the eleventh month, to say that No. 169 is only "a 'Wooten' engine and not a representative of the American type at all," that the designer of the engine, which is "a patented design" had probably in view "steam generating regardless of economy," &c. Moreover, he gives it to be understood, that the fact of its being beaten by the engine "Gladstone" proves nothing, because it has been beaten badly by an engine belonging to the New York, New Haven, and Hartford Railroad Company, which, he says, "was an ordinary typical American engine."

Having disposed of engine "No. 169" in this summary fashion, Mr. Smith next throws the New York and Hartford engine on one side, and runs out a fresh engine—a "Meehan" engine—as "a representative design of the American type," and cheerily challenges me, like "Cleveland," to enter the lists with a British engine. The performance, however, of this said "Meehan" engine—which, by the way, Mr. Smith inadvertently blurts out is an exceptionally powerful American engine—does not show anything very remarkable, and I have no doubt I could, without much research, put my hand on the recorded performance of a dozen, or more, typical British engines to beat its performance hollow. But what would be the use? In ten or eleven months hence, when the facts were forgotten, we should have another Mr. Smith from U.S.A. writing to say that the "Meehan" engine wasn't a "representa-

tive of the American type at all," and that Mr. Burnett had no business to make "a comparison of what *he calls* an American engine." Mr. Smith, *secundus*, would then start another hare, in the shape of some other new-fangled American locomotive, and so the sport would go on in a fruitless, will o' the wisp search for a *real* "representative of the American type" of engine. Life is too short for such an enterprise!

But so far as Mr. Smith supplies data of the "Meehan" engine, the "Gladstone" engine holds its own with the "Meehan," without going further afield. It is true that Mr. Smith, by *squaring* the number of pounds of fuel per indicated horse-power per hour consumed by the "Gladstone" engine at 43.3 miles per hour, converts 2.05 lb. (the "Gladstone" consumption at 43.3 miles per hour) into 3.48 lb. at 56.6 miles per hour, on the assumption, as he says, and perhaps a true assumption, "that the *resistance* increases as the square of the speed," one of the most free and easy, not to mention *absolutely incorrect*, ways of handling figures to make out a *primâ facie* case in favour of the "Meehan" engine that could well be imagined. Why did he not *cube* 2.05 at once, and so get a still higher figure for comparison?

Having got in this way his 3.48 lb. per indicated horse-power per hour, as the (estimated) consumption of the "Gladstone" engine at 56.6 miles per hour, Mr. Smith compares it with the "3 lb." of the "Meehan" engine at the same speed, and triumphantly exclaims: "Which is considerably in favour of the 'Meehan' engine." This, however, is his one solitary "score" in favour of the "Meehan" engine.

After this *exposé* of Mr. Smith's treatment of the subject he champions, I feel sure your readers would regard it as a needless use of your columns if I were to trouble you with any further comments on Mr. Smith's letter. I therefore conclude with thanks for the space you have already given to my communications, and remain, Sir,

Your obedient servant,
ROBT. H. BURNETT.

Victoria-street, Westminster, Feb. 15, 1887.

P.S.—The reason why I selected the engine "Gladston" for comparison with "No. 169" will be found by Mr. Smith in my letter in your issue of December 24 last.

THE MANUFACTURE OF MACARONI.

TO THE EDITOR OF ENGINEERING.

SIR,—Can you or any of your readers inform me whether there are at present any *home* manufacturers of macaroni and vermicelli? I am aware a factory for this purpose was fitted up in the north of London some fifteen years since, but I cannot trace that it exists at the present time. Can you also enlighten me as to the machinery required for the manufacture of these materials?

Your obedient servant,
M.

Greenwich-road, London, February 7, 1887.

TESTING DYNAMOS.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the correspondence on the above subject, I wish to point out briefly why the methods suggested by Mr. Fuge for electrical measurement of the commercial efficiency of a dynamo and the frictional loss on its rotating armature are impossible.

Mr. Fuge bases his method entirely on the assumption that in a series dynamo the following three ratios are equal:

$\frac{E\,C}{W}$ (when run as a dynamo);

$\frac{W}{E_1\,C}$ (when run as a motor, current and speed being constant);

and

$\frac{w}{e\,c}$ (when running as a motor with no load at same speed).

It can easily be shown that neither of these three ratios are equal, for as a dynamo we have

$$W = C^2\,R + K + E\,C,$$

where R = resistance of machine,
and K = loss of power by self-induction and Foucault currents.

As a loaded motor running at same speed, and taking same current, we have

$$E_1\,C = C^2\,R + K + W,$$

K being the same as before, since the current and speed are constant.

And lastly as a motor running light at same speed,

$$e\,c = c^2\,R + K_1 + w.$$

Combining these equations, it will be seen that, so far from the above three ratios being equal, we have the following relations between them:

$$\frac{W}{E_1\,C} = \frac{P + E\,C}{P + W} = \frac{w}{e\,c} + \left(\frac{P_1}{e\,c} - \frac{P}{E_1\,C}\right),$$

where for brevity $(C^2\,R + K)$ is written P, and $(c^2\,R + K_1)$ is written P_1, which upsets the basis on which the whole method is worked out.

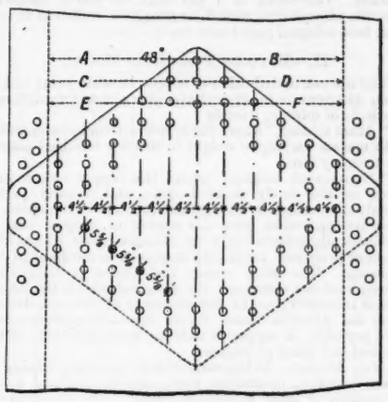
I am, yours truly,
H. D. WILKINSON.

School of Electrical Engineering, 12, Princes-street, Hanover-square, Feb. 16, 1887.

JOINTS FOR CYLINDRICAL BOILERS.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the letters published in your issues of the 7th, 21st, and 28th ultimo, on the above subject, I send herewith a sketch of a joint designed some years ago, but never put in use, for somewhat similar reasons to those given by one of your correspondents. Although not professing to exceed the solid plate, the results are sufficiently near to be of great practical value, and the injury to the outer rivets through stretching of the plate, is to a great extent obviated by the style of landing. The



Lap Joint, Plate 1" Rivets 1⅛"

Section A B = $\frac{48 - 1 \cdot 125}{48} \times 100$ = 97·6%

Section C D = $\frac{48 - (3 \times 1 \cdot 125) + \frac{334 \times 1}{48 \times 1}}{48} \times 100$ = 95·0%

Section E F = $\frac{48 - (5 \times 1 \cdot 125) + \frac{394 \times 4}{48 \times 1}}{48} \times 100$ = 96·5%

Rivet Section $\frac{64 \times \cdot 394 \times 23}{48 \times 1 \times 28} \times 100$ = 108·8%

formula you will observe is simple; let P = longitudinal pitch, D = diameter of rivet, the diagonal pitch or $P_1 = P + D$. By increasing the rivets to $1\frac{3}{8}$ in. in diameter in the examples shown, the plate section will be reduced about 1 per cent., while the rivet section will be increased about 50 per cent.

Some of your correspondents may see objections not noticed by

Yours truly,
A. T. ORR.

Aberdeen, February 8, 1887.

THE INTERCHANGEABLE AUTOMATIC BRAKE.

TO THE EDITOR OF ENGINEERING.

SIR,—On reading your paper this week I find that you have inserted a notice of the trials of the interchangeable automatic brake, which took place on February 9. So far as the descriptive portion of your article is concerned I have nothing to remark except to express my thanks, but as your criticism, being no doubt somewhat hurried, is rather unfavourable to the new brake, I should be glad if you would allow me the opportunity of saying a few words in explanation, as the result of a much more extended experience of the brake than the explanatory trials referred to.

In the first place, the interchangeable automatic brake is not intended to be, nor is it in any way a "compromise" between the Westinghouse and vacuum systems. On the contrary, as it is the only permanently "automatic" brake in the market, it is intended that eventually it should supersede both; and this is one of the reasons for making it adaptable either for air pressure or vacuum, so as to be suitable for the transitional stage.

The trials on Wednesday were not arranged with the view of showing a brake perfect in all its minor details, but for the purpose of demonstrating the practicability of the principles involved in the brake, and for this purpose six trucks were considered ample.

I may mention that the difficulty with this brake in the first instance was not its slowness of action, but on the contrary, its extreme suddenness, which, however, was easily remedied by suitably reducing in size the inlet holes to the cylinders, and I would draw attention to the fact that only *one-eighth* the quantity of air is used in applying the brake, as compared with the Westinghouse system, so that the train pipes and pumps have a correspondingly less duty to perform.

As the diagram you publish is reproduced from one intended to demonstrate in a popular manner the action of the brake, it may be worth mentioning that the brake blocks are in all cases applied to both sides of the wheels by the same toggle gear, so that there is no more strain on the horn-plates or underframe than in the case of any other equally powerful brake.

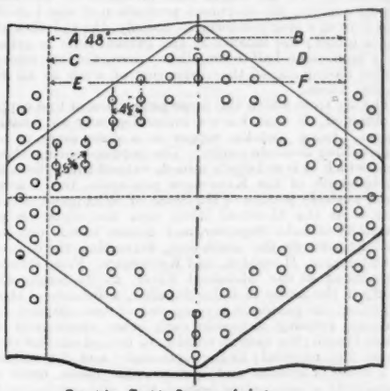
Up to the present not the slightest indication of excessive rigidity in the toggle gear (which you fear), nor any unwillingness of the brakes to come gently off has been observed, although experiments of great variety have been repeatedly tried.

No doubt the reason why toggle gear has not up to the present been adopted for brakes is the absence of the automatic "take-up gear," which, in the interchangeable brake, is such a complete success.

I have no wish to make disparaging remarks on the Westinghouse or any other brake which has done such good service, but as you have taken the initiative in comparison, I must draw your attention to the following facts, which I think you will allow are very favourable to the interchangeable brake:

1. The ordinary double-piston cylinders in the Westinghouse are dependent on springs for the return strokes, and have *two sliding joints* (not one), which are practically the same as the interchangeable, except that the latter requires no springs.

2. When once the Westinghouse brake has been applied



Double Butt Strap Joint.
Plate 1", Rivets 1⅛", Straps ¾"

Section A B = $\frac{48 - 1 \cdot 125}{48} \times 100$ = 97·6%

Section C D = $\frac{48 - (3 \times 1 \cdot 125) + \frac{334 \times 1 \cdot 75}{48 \times 1} \times 100}{48}$ = 96·5%

Section E F = $\frac{48 - (5 \times 1 \cdot 125) + \frac{334 \times 1 \cdot 75}{48 \times 1} \times 100}{48}$ = 102·7%

Rivet Section $\frac{39 \times \cdot 394 \times 1 \cdot 75 \times 23}{48 \times 1 \times 28} \times 100$ = 98·3%

and the vehicle has been disconnected from the engine, the brake is completely "dead" until again coupled up to the air pump. The interchangeable is always ready to work with full power, and *can be operated by hand at any time.*

3. In descending long inclines, or when necessary to stop on such inclines for any length of time, loss of pressure through leakage renders the action of the Westinghouse brake more and more uncertain, and to apply the brake with more power it is necessary first to *completely take it off* and recharge the reservoirs under each vehicle, an operation which, under certain conditions, would involve serious danger of accident. On the other hand, any leak in the interchangeable brake tends to apply the brake with greater force; the brake can be left "on" for an indefinite period, and this possesses numerous advantages.

4. The Westinghouse system depends on the action of that extremely ingenious, though somewhat complicated, piece of mechanism, the triple valve. No valve of any sort is used in the interchangeable.

5. The Westinghouse system uses eight times the quantity of air for each application of the brake that the interchangeable does.

6. The interchangeable brake is at all times capable of perfect graduation, and can be released at the moment of stopping, so as to obviate that excessive strain to the rolling stock with which we are so familiar in the Westinghouse.

In conclusion, I am entirely of your opinion that the safety of the travelling public demands the use of the best possible brake, and it is because I am so firmly convinced that the interchangeable automatic brake is that "best possible brake" that I have ventured to take up so much of your valuable space.

WILFRID STOKES.

5, Westminster Chambers, February 15, 1887.

[Believing, as we do, that the merits and demerits of the various systems of continuous brakes cannot be too thoroughly discussed, we willingly insert Mr. Stokes's letter, although we cannot accept all his conclusions. We shall deal with the matter further in an early issue, but meanwhile some of our readers who have experience with the brakes now in use, and who know the difficulties to be overcome in the practical working of such brakes, may like to have something to say on the subject. At present we need only remark that Mr. Stokes does not explain why the quantity of air required to lift a given weight should only be one-eighth of that necessary to exert the same pressure in an opposite direction, nor does he meet our objection that in the brake he upholds, the sliding joints are always exposed to air leakage.—ED. E.]

LAKE SUPERIOR COPPER MINING.

*On Copper Mining in the Lake Superior District.**

By Mr. EDGAR P. RATHBONE, of London.

IN the present paper the author purposes dealing with the subject under the three following divisions:

I.—General description of the district.
II.—Methods pursued in mining.
III.—System of ore dressing, and machinery employed.

I.—GENERAL DESCRIPTION OF THE DISTRICT.

The district of Lake Superior has for a long series of years been the principal centre of copper mining in the United States, and continues to be so at the present time.

* Paper read before the Institution of Mechanical Engineers.

The total production of fine copper in the United States in 1885 is estimated at about 83,000 tons (American tons of 2000 lb., equivalent to about 74,100 English tons). Of this quantity 36,000 tons were produced from the Lake Superior district alone, the balance being credited chiefly to the States of Montana and Arizona, of which the former produced about 33,000 tons, and the latter about 11,000 tons. Of the 36,000 tons produced by the Lake Superior mines, the enormous production of about 23,600 tons is from a single enterprise, namely, the Calumet and Hecla mines; the balance at the present time is principally from some half-dozen other mines, the low price of copper having caused the suspension of work at all the smaller mines.

The ore from which this large production of fine copper is obtained, is that known mineralogically as "native copper," being metallic copper in a state more or less approaching absolute purity. The copper-bearing strata from which it is so largely mined, extend throughout the whole length of the Keweenaw peninsula, the extreme north-westerly portion of the State of Michigan; it commences at the Montreal River near the south-western extremity of Lake Superior, and thence trends out into the lake towards the north-east, traversing the counties of Ontonagon, Houghton, and Keweenaw. From its commencement at the Montreal River, to its termination nearly in the centre of Lake Superior, a distance of about 150 miles, the peninsula is composed of two distinct formations, running alongside each other throughout its whole length; the eastern consists of beds of silurian sandstones dipping gently to the south-east; and the western of a series of igneous and metamorphic rocks, made up principally of alternating beds of trap and conglomerate, which dip to the north-west at inclinations varying from 55 deg. to 60 deg. in the Portage Lake district and from 23 deg. to 33 deg. elsewhere. The trap rocks appear to be composed principally of melaphyr (augitic porphyry devoid of quartz) and diorite (hornblendic porphyry); the former is frequently of a distinctly amygdaloidal character. The conglomerates consist of an agglomeration of small pebbles and boulders, doubtless of glacial origin, cemented together by a hard felspathic mass. Throughout these rocks the copper does not occur in true fissure veins, but rather in beds, or as they are not inaptly termed in the district "belts," dipping at the same inclination as the "country" or rock inclosing them. For simplicity, however, the term "veins" will be used for these particular copper-bearing beds or belts.

From exhaustive scientific investigations into the origin and derivation of the copper in these deposits, it appears probable that it was infiltrated into them in the form of an aqueous solution of copper, which also appears to have had a strong chemical affinity for special constituents of the rocks, thereby giving rise to a series of chemical reactions, whence resulted the precipitation of native copper in a more or less concentrated state, according to the proportion and the even distribution, or otherwise, of the precipitating or displacing agent present in the original rocks. In the amygdaloidal trap rocks the displacing agent appears generally to have been less evenly distributed than in the conglomerates, or at any rate less evenly than in the beds of conglomerates worked in the Calumet and Hecla mines, where the copper is found in a fine state of division and very evenly disseminated throughout the whole of the veinstone proper; it is this cause alone which renders these mines probably the richest in the world. In certain places the concentration of the displacing agent has been so excessive as to give rise to the formation of large masses of copper, which will be subsequently referred to. Whether or not the precipitating action was connected with some natural process of leaching or lixiviation, influenced by terrestrial electrical currents, it is impossible to decide. In the amygdaloidal trap rocks the veinstone is frequently composed largely of epidote, a mineral whose presence is regarded as favourable or "kindly" to copper. Other minerals found in association with the hornblendic and augitic porphyries that constitute the veinstone proper are quartz, calcspar, and many varieties of the zeolite group.

The percentage of copper distributed throughout the veinstone, so far as concerns practical mining, may be said to range from 0.75 per cent., as at the Atlantic mine, to about 4 per cent. as at the Calumet and Hecla mines. Native silver of remarkable purity is occasionally found in association with the copper; but seldom in quantity sufficient to render its extraction commercially profitable.

The commercial copper smelted from these ores, being entirely free from all deleterious matter, such as arsenic, bismuth, antimony, &c., is especially valuable for electrical purposes. In a paper by Mr. Preece on electrical conductors* it was stated that, while in 1861 electricians were content to specify that copper should not fall below 85 per cent. of purity, they now specify 96 per cent., and indeed find no difficulty in getting an electrical conductivity equal to 99 per cent. of purity. It was also stated that a mere trace of arsenic in copper reduced its conductivity 40 per cent., while contact with air when in a molten state reduced it 24 per cent.; and further that the carrying capacity of a cable for messages is increased in the same proportion as the conductivity of the copper is improved, so that a cable of the copper of to-day will carry twice the number of messages that a similar cable of copper would in 1858. Owing to its greatly superior conductivity, as compared with that of iron, it would appear probable that copper or some alloy of copper will before long supplant iron for aërial telegraph wires. At its present low price of 11 cents per pound, or about 50*l.* per English ton, it should not cost more per mile than iron, when its greater efficiency is taken into consideration.

It is in the manufacture of brass however that the largest quantity of copper is employed. In this connection it is antimony which is most deleterious; one-tenth of 1 per cent. converts first-rate "best selected" into the worst possible; one-fortieth of 1 per cent. renders it unfit for anything but inferior brass; and one-eightieth of 1 per cent. changes it from "best selected" to "tough ingot" quality. One-tenth of 1 per cent. of either bismuth, arsenic, phosphorus, nickel, or cobalt is sufficient to convert best selected into tough ingot.

* Proceedings of the Institution of Civil Engineers, 1883, vol. lxxv., pages 64 and 65.

II.—Methods Pursued in Mining.

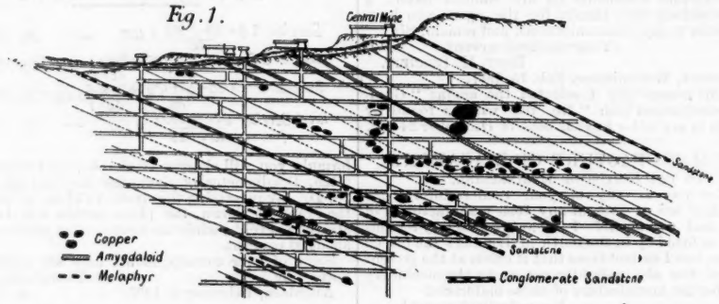
The uneven distribution of copper in some veins and its even distribution in others have give rise to two different methods of mining, namely:

"Mass mining," where the copper is found concentrated into masses varying in weight from a few hundred pounds up to many tons.

"Stamp-rock mining," where the copper occurs in a more or less finely divided state, and usually pretty evenly disseminated throughout the whole veinstone, so that its separation from the matrix or gangue can be economically effected only by stamping and by the subsequent processes ordinarily employed in mechanical ore dressing. The more evenly the copper is distributed throughout the veinstone, the more valuable is the latter; and it is largely due to the evenness of the distribution that the Atlantic mine, whose veinstone produces only 0.75 per cent. of copper, is able to work profitably at the present low price of copper.

Mass Mining.—In the early history of copper mining on Lake Superior, operations were entirely confined to the extraction of large masses of copper. As shown in the accompanying longitudinal section, Fig. 1, the method of

Fig. 1.



mining consisted in sinking a number of shafts following the inclination of the vein and at short distances apart, and connecting them in the usual manner by a series of levels. The ground thus laid open was then stoped or worked away, by breaking the veinstone away close to the underside or foot-wall of the vein, masses of copper (shown black in Fig. 1) being more frequently discovered on the foot-wall than on the hanging wall or upper side of the vein. On the discovery of a large mass during this operation of stoping, the next process was that of desuing, or working away the surrounding ground so as to lay the mass bare all round; formerly very large quantities of powder were employed for this purpose, many kegs of powder being used in one blast. As soon as the extent of the mass has been definitely ascertained, and it is fairly liberated from the inclosing veinstone, it is cut up by hand with chisels into pieces of convenient size for handling in the mine and then hoisting to the surface, the weights ranging from 1000 lb. to 3000 lb. "Barrel copper" is the name given to pieces of such size as can be conveniently packed into ordinary petroleum barrels.

The most productive mines belonging to this class occurred in Ontonagon county; the most important were the Minnesota and National mines, both of them working on the same vein. One mass discovered in the Minnesota mine is said to have weighed over 500 tons, and another in the National nearly 1000 tons. Some large masses have also been discovered in mines situated in Keweenaw county, notably in the Cliff mine, which is said to have produced several masses weighing over 300 tons each; the Phœnix mine is credited with a mass of 600 tons, and the Central with several of about 150 tons each. These large masses, however, are quite exceptional; for the most part the masses do not weigh more than from 1 to 15 tons.

The value of an exceptionally large mass of native copper imbedded in a hard rock is not so great as would at first sight appear. Thus thirty separate masses of from 1 to 15 tons, and equal in the aggregate to 300 tons, would yield a larger profit, supposing them to be discovered in fair proximity, than a single large mass of equal weight. Moreover the occurrence of the large masses is so irregular, and the amount of exploratory or "dead" work betweem them is frequently so great, and other difficulties of working are so considerable, that it is found that a mine with a more or less regular percentage of copper disseminated in particles throughout the veinstone, is of far greater commercial value. Of late years diamond drills have been introduced for the purpose of discovering by boreholes the position of these masses and of rich veinstone, so as to avoid as far as possible the extraction of barren ground. In earlier times, when copper was worth double and even treble as much as now, enormous profits were realised from some of the mass mines. Thus the Minnesota mine is stated to have repaid the whole of the capital outlay more than four times over during a period of about twenty years. Since the discovery of rich "stamp rock" veins, mass mining has been almost entirely abandoned; and the once populous and flourishing district of Ontonagon county, in which many of the richest mass mines were situated, is now almost completely neglected. This, however, is not because stamp-rock veins do not occur there; but rather because there is seldom a sufficiency of water to supply a large Ball stamp-mill, without which veins of this description cannot be profitably worked.

(*To be continued.*)

ROYAL METEOROLOGICAL SOCIETY.

The usual monthly meeting of this Society was held on Wednesday evening, the 16th inst., at the Institution of Civil Engineers, 25, Great George-street, Mr. W. Ellis, F.R.A.S., President, in the chair.

Mr. E. T. Edwards, Mr. D. FitzGerald, Mr. T. B. Groves, F.C.S., and Mr. W. W. Midgley were elected Fellows of the Society.

The adjourned discussion on the Hon. R. Abercromby's paper "On the Identity of Cloud Forms all over the World; and on the General Principles by which their Indications must be Read," was resumed; and the following papers were read:

1. "*Remarks Concerning the Nomenclature of Clouds for Ordinary Use*," by Professor H. H. Hildebrandsson, Hon. Mem. R. Met. Soc.

2. "*Suggestions for an International Nomenclature of Clouds*," by the Hon. R. Abercromby, F.R. Met. Soc. Both Professor Hildebrandsson and Mr. Abercromby have paid great attention to the question of the forms of clouds, and having recently conferred together, they have agreed to recommend for international use the following ten principal varieties, viz.—High-level clouds: cirrus, cirro-stratus, cirro-cumulus; middle-level: strato-cirrus, cumulo-cirrus; and low-level: cumulus, stratus, strato-cumulus, nimbus, cumulo-nimbus.

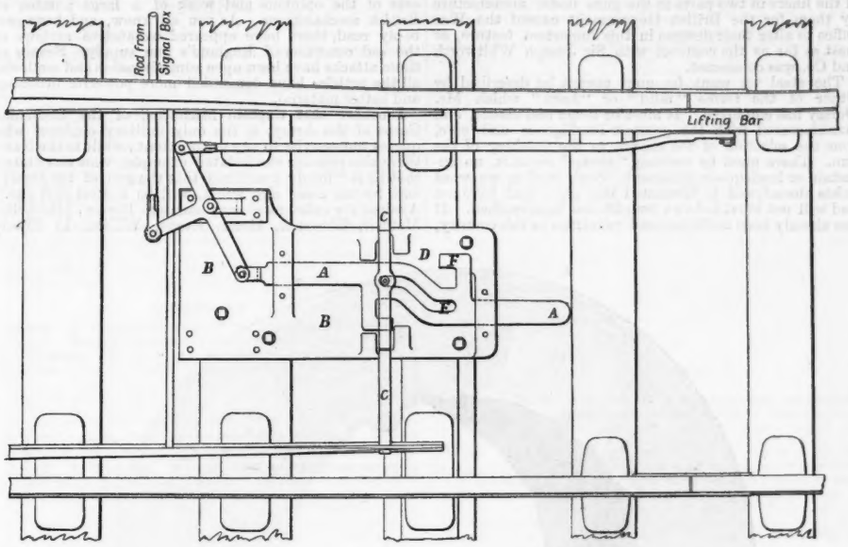
3. "*The Influence of Weather on the Proportion of Carbonic Acid in the Air of Plains and Mountains*," by Dr. W. Marcet, F.R.S., and M. A. Landriset. The authors give an account of some experiments which they have made on the proportion of carbonic acid in the air at Geneva and on the summit of the "Dole," the highest point of the Jura chain, the difference in altitude being 4193 ft. The results of these experiments show (1) that in fine clear weather on a mountain chain of moderate Alpine altitude and in the adjoining valley or plain, the atmosphere holds the same mean proportion of carbonic acid at both places; and (2) that when the summit of a mountain chain is in a fog, a circumstance which frequently happens in an Alpine district, the air in the fog contains a smaller proportion of carbonic acid than it would hold in fine clear weather.

The secretary, Dr. Tripe, read a letter received from Sir F. Abel, organising secretary to the proposed Imperial Institute, inviting the Society to draw the attention of the Fellows to the undertaking, with the view of their contributing towards it. The President stated that copies of the letter and of the accompanying paper, explanatory of the scheme, would be forwarded to each Fellow.

Locomotives on the Pacific Coast.—Twenty-five heavy locomotives have been recently ordered for use on the California and Oregon Railroad. They will be of the largest class, and similar to those in use on the Tebachapi division of the Southern Pacific Railroad.

Water Supply in Queensland—The work of supplying and storing water in the interior of Queensland proceeds satisfactorily. A new boring machine has been sent out to Mount Margaret, and is supposed to be capable of boring at a depth of from 700 ft. to 800 ft. Good water has been struck on the Delta on the Jericho and Blackall roads. A deep bore at Blackall has been suspended for a short time while reaming, and casing has been put down, but work is about to be resumed. Contracts have been let for three tanks on the Boulia and Winton road—one at the Hamilton, another at Macunda Creek, and the other about 153 miles from Winton. The water supply department is preparing for operations on the Boulia and Cloncurry roads, and the supply of water will be chiefly from wells. On the Richmond and Woolgar roads the tank at the Burnt Creek yards is finished. The excavation was 25,000 cubic yards. With work at Landsborough Creek, on the Hughenden and Muttaburra road, good progress has been made. Surveys of proposed water works at Normanton have been completed, and the drawings and plans will be put in hand immediately. The surveyors have gone to Burketown to make surveys for a water supply, and a set of drawings for the Charters Towers water supply has been finished.

LANGLEY AND PRINCE'S LOCKING GEAR FOR SWITCHES



THE switch-moving and locking mechanism, which we illustrate above, is the invention of Messrs. Langley and Prince, the former of whom is the engineer to the Midland Railway at Derby. The distinctive feature of the arrangement is that only one lever is required in the signal-box to perform the double duty of moving the points and of unlocking and locking them. Both these functions find their origin in the sliding plate A, the locking being done by the projections F, which take into slots in the bar C connecting the points, and the tongues being moved by the roller D working in the curved slot E in the plate. When the man in the signal-box pulls over the lever the plate A is drawn endwise; first, the crossbar C is unlocked, then the roller enters the curved part of the slot and puts over the points, and finally the second bolt F locks the bar again. The lifting bar is operated by a rod from the bell-crank which works the sliding plate.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, February 3.

DURING the past six days the American iron market has advanced in crude material and in bridge iron, all other kinds remaining where they were two weeks ago. No. 1 foundry iron sells at from 20 dols. to 22 dols., delivered in the markets, and No. 2 is in active demand at 20 dols. to 21 dols. Grey forge iron is delivered at mill from 19 dols. to 20 dols., according to quality. Large orders are exceptional, small orders are abundant. Heavy buyers decline to pay the advance and small buyers are paying only for what they must have to complete contract work in hand. Bridge iron has been advanced within a few days to 2.30 for angles and 3.30 for beams and channels. Wrought-iron pipe will probably advance before March 1, on account of the very urgent inquiry from all sides and the heavy consumptive requirements that are known to exist, especially for natural gas purposes. Steel rails continue at 39 dols. to 40 dols., but large buyers refuse to do business at this figure, having secured supplies for months to come at 34 dols. to 35 dols. The small buyers, which include the railroad companies who need small lots for repairing purposes, are obliged to come into the market and pay the present prices. Rail blooms are quoted at 30 dols. to 30.50 dols. Naylor and Co. have contracted for over 200,000 tons of steel for importation this season. There are inquiries for large lots, but business is impeded by the extreme quotations insisted upon by makers. Plates and slabs for various purposes are in active inquiry, although there is nothing of moment doing from day to day. The American mills are dependent almost exclusively upon foreign sources for scrap and old rails, and are receiving barely sufficient material to keep them going from month to month. Old tee rails are selling at tide water at 25 dols. to 25.50 dols., double heads at 26 dols. to 26.50 dols. Inquiries are in hand this week for 20,000 tons of bridge building material, and the structural works are filling faster than they have filled up during the winter season for several years. By the opening of spring the capacity will be absorbed for the entire summer, and a further advance of one-tenth cent, or perhaps two-tenths, will be made within the next six weeks. The nail factories are crowded with orders on account of the heavy house and shopbuilding requirements. The establishments for the furnishing of small lots of railway material equipments of all kinds are extremely busy, as nearly all the railroad companies are in the market for supplies of one kind or another.

STEEL FOR HEAVY GUNS.*

By Lieutenant WM. H. JAQUES, U.S.N.

THE theories and opinions presented in Mr. Dorsey's paper† have been so effectually refuted in the able discussions to which we have listened this evening, that there remains little or nothing to be said in relation to the technical questions therein. But there is another point of view from which it may be considered, and that is the effect which it and similar papers in the general press, may have upon the general public, coming as it does from a civil, instead of a military, engineer.

At a dinner given by the New England Society in one of our large cities, an admiral of our Navy, in response to the toast, "The Navy," said if the length of his speech was to be governed by the size of our Navy, he had already said too much. I do not recall, at the present moment, anything more pertinent to apply to the paper under discussion, if its application to gunmaking is alone to be considered.

When I heard that it was to be read and discussed to-night, I was opposed to its consideration, for I believed it unworthy of the prestige which publication in the Proceedings of this Institute would necessarily give it. But as it has been the means of bringing together the intelligent men whom I see before me, has furnished a motive for an interesting and spirited discussion, and has given an opportunity for the presentation of the opinions of men pre-eminent in their respective professions, I must thank the writer, so far, for his success.

Though he has intimated that his argument is based upon the "experience and opinion of all the principal steelmakers of the world," his several trips to Europe and elsewhere appear to have been fruitless, for we can find nowhere in his paper any opinion that is in accord with the accepted authorities on special steels, either in Europe or at home. In fact, as has been so repeatedly said this evening, he has displayed his utter ignorance of the subject he has attempted to discuss.

The arguments to which we have already had the pleasure of listening have so completely disposed of the claims and conclusions contained in his paper, that it is unnecessary for me to do more than to ask you to recall the opinions of various high authorities in the United States who have taken the interest and trouble to give important committees the benefit of their experience and knowledge. A glance at the report of the Senate Committee on Ordnance and Warships alone will show the wide range of investigation that was conducted. It is needless for me to state that the testimony to which I refer does not accord with the views Mr. Dorsey advocates. Neither does the letter just read from Mr. Wellman. Nor in the letters expressing a preference for his "cheap material" will he be able to find much sympathy, for even Mr. Thurston, by his eulogy on Whitworth steel, at the close of his communication read to-night, completely destroys the value of his argument in the first half, and makes his indorsement of Mr. Dorsey's opinions more injurious than helpful.

What Mr. Morgan and Mr. Davenport have said this evening must convince all who have heard them, and all who will read their discussion hereafter, that our military (employing it in its comprehensive sense, with reference to both branches of the service) engineers have the hearty indorsement of all those civil and mechanical engineers who have made a careful study of its application of steel to ordnance purposes. I will not quote, therefore, from the powerful evidence which they have from time to time given on this question.

Notwithstanding all this positive testimony from the leading managing and mechanical engineers of the country, the advocates of "cast iron" and "mild steel" for ordnance materials claim, in speaking of the failures of guns in Europe: "This is what might have been expected. Every steelmaker who is not a gunmaker says these large masses cannot be forged so as to be safe from injurious strains. Every mechanical engineer who is worthy of the name knows that such masses of rings and tubes cannot be fitted and assembled so as to act as a continuous whole; and even if they were so fitted, they could not be retained in that condition after the warming up of the first few rounds."

Does the evidence to which we have referred indorse either of these unwarranted statements? Are they proved by the splendid treatment that Whitworth and Schneider give their metal, and by the interesting experiment made by Sir Joseph Whitworth to illustrate the effective power of shrinkage?

[*From Proceedings Naval Institute, No.* 31.]

"Plate XXXVI. (see engravings on next page) presents the result of a most important and interesting experiment made by Sir Joseph Whitworth to illustrate the effective power of shrinkage. The ring was made of mild, fluid-pressed steel, and was heated and shrunk on to a plug 18 in. in diameter. When cold, the plug was forced out by an hydraulic pressure of 3200 tons.

"The experiment thoroughly proved the union of the two parts, and is an excellent test of the merits of shrinkage without the interposition of any other metal."

Far from it! On the contrary, they are the evidences and practical results which aided the Gun Foundry and Fortifications Boards to make their valuable reports, and the Senate Committee on Ordnance and Warships, in General Hawley's positive and comprehensive report, to present the following conclusions:

All the guns in our Army and Navy, save the modern steel rifles ordered for the monitors and cruisers, are of classes whose manufacture is abandoned by the nations which have devoted themselves to perfecting cannon.

The argument based upon the alleged economy of the cast-iron heavy rifle has been steadily losing force by reason of the constant cheapening of the processes of making gun steel, and the increasing ease of forging it in large masses.

When a comparison is made between two guns giving an equal energy, it is found that the steel gun weighs but little more than half its competitor, and costs but little more. Such are the manifest uncertainties and weaknesses of the cast-iron gun, that the argument may be considered closed. This is the emphatic judgment of Europe, and in accepting that judgment this committee concurs with our own officers and experts.

In every detail the advance of the last twenty-five years has been wonderful. The adoption of slow-burning powders, producing greater force with reduced strain, necessitated longer guns, whose use was made possible by breechloading mechanism, bringing with it an increased rapidity and safety of loading. The attempts to make long rifles of cast iron, or of iron and steel, have been abandoned (and the value of wire-wound guns is still a question), since open-hearth steel and hydraulic forges have made comparatively easy the forging of 75-ton ingots of homogeneous steel exhibiting the highest qualities required for guns.

The costly experiments of twenty-five years have reached a stage which justifies certain conclusions. Guns should be made of open-hearth steel, forged, breechloading, chambered, of calibres ranging from 5 in. to 16 in., of lengths ranging from thirty to thirty-five calibres. Armour and projectiles should be made of forged steel. The hydraulic forging press produces better results than the steam hammer, costs much less, and should be used for Government work.

The objections that have so frequently been given by those individuals whose systems have been rejected—viz., that military boards always exclude the ideas and inventions of the civilian that their own may be introduced and adopted—can have no pertinency in the consideration of the conclusions of the reports from which I have quoted, based as they were upon such a wide civil investigation; while the Fortifications Board, as you all know, had the benefit of the valuable services of the representative from Cambria, who has honoured us with his presence to-night.

I have asked your consideration of these facts to emphasise the assertion that any attention paid to the wild theories of the iconoclasts, whose limited research and want of experience preclude a consciousness of their own ignorance, is not only an injustice to scientific students and practical men, but an impediment to the inauguration of that defence in which the whole country now believes.

Mr. Dorsey's scepticism in regard to the improvement of large masses of gun steel by oil-treatment is indorsed by men of authority, and even so late as October last, by so prominent a one as the newly elected President of the British Iron and Steel Institute, Mr. Daniel Adamson, who, at the autumn meeting, expressed his want of confidence in "hardening in oil," even to "recommending the Government at once to consider, and to abandon it, if they came to the same conclusion that he had done—that the method was injurious at all times, and never desirable." He thus disputed the firm ground held by Professor Akerman, that "hardening in oil was a very important method for strengthening guns."

Mr. Vickers gave evidence that his experience of fifteen

* Paper read before the United States Naval Institute.

† See ENGINEERING, page 69 *ante*.

years was very much in favour of treating steel with oil; and a visit to his works in Sheffield would convince you all, not only of its utility, but that Mr. Vickers had many practical reasons for his indorsement of oil treatment.

As early as 1863 we find prominence given to strengthening by oil treatment. In the statement of Mr. Whitworth before the English Ordnance Committee, in advocating built-up steel guns, we find: "I go with Krupp, of Essen, the manufacturer of homogeneous metal. It is highly desirable it should be of right temper and properly manipulated." Since then its importance has greatly increased, and its use become more general. In fact, no gunmaker would be willing to take the responsibility of omitting it. In addition to gun, armour and projectile steel, shafts, hydraulic cylinders, rolls, rods, and other parts of machinery have been improved by oil treatment, and the variety of its application is constantly increasing.

While the very general practice of oil treatment has not reached a point where its results can be called conclusive, they are sufficiently definite to govern the most reliable manufacturers in their treatment of steel, and to enable them to produce very satisfactory results in large pieces.

It will be of interest to refer to a statement made last year by a member of the British Iron and Steel Institute, which was a public expression of the opinions held by many Englishmen: "During the last year or two some of our most prominent artillerists have been advocating the use of milder steel, both for the barrels and hoops of guns, than has previously been thought desirable, or than is necessary to pass the Government tests; and many of the guns now made for foreign Governments are of a material the elastic limit of which is 25 tons, ultimate strength 33.9 tons per square inch, and elongation 29 per cent. in a length of 2 in., when tempered at 1600 deg. Fahr. The subject of tempering and annealing is one which has not yet received, even at the hands of steelmakers, the attention of which I believe it to be worthy, and its methods of manufacture and working are therefore not so thoroughly understood as those of the softer steels, which are sent into the market in the form of boiler and ship-plates, angles, bars, tees, girders, and other sections; and although any decided increase in the hardness of these things would, no doubt, lead to many serious difficulties, several eminent engineers have, during the last year or two, advocated the employment of steels of greater tensile strength for bridge-building and some other purposes than have hitherto been thought advisable. I think that most people will be ready to admit that the quality of the materials supplied for the construction of our weapons of war should be the highest possible, almost even regardless of cost, when so much may depend upon the safety and endurance of our guns, or on the power of their projectiles to penetrate the armour-clad forts or ships of an enemy."

If it be true that fair results can be obtained with "mild steel," though badly worked, this should be a powerful reason why it should be avoided, not only for heavy guns, but for every other purpose where certainty and reliability and strength are required. A pertinent remark in regard to this will be found in the *Army and Navy Register* of June 26 last, where, in an article on "Modern Artillery," reasons were given to account for the failures of English material. "The difficulty lies," says the writer, "in the fact that English manufacturers furnish the cheapest steel in the world; and in order to make cheap steel into guns it is necessary to lower the Government requirements of physical characteristics, temper, &c., to a point where no reliable gun can be made. The very best material must be used in the composition of the steel, or it will not stand the work that it is necessary to put into it to make it homogeneous; that material and that work must be paid for."

Is it, then, of such material as Mr Dorsey advocates that military engineers should construct guns to sacrifice their country and their fellows? Is it to such material that military engineers are to yield, just as they have succeeded in securing a production from steel manufacturers who (after enormous expenditure) have reached a point where they can guarantee the uniformity and homogeneity, as well as the other requisites, of reliable gun metal?

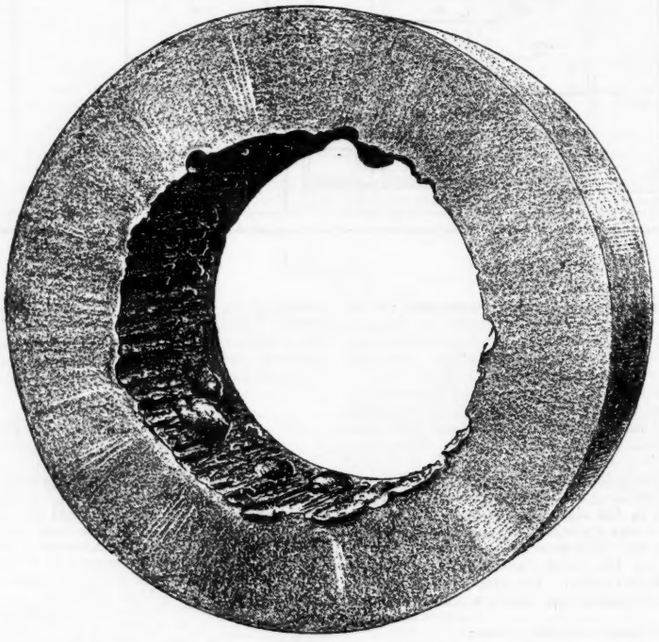
Is it with such material that we are to invite similar failures (they will certainly come if we use the stuff he advocates) to those he condemns in England? I am sure no ordnance officer in either of our departments would think of advocating such a policy, and no one would dare do it, if he were required to stand by and fire his own guns.

An eminent artillerist said to me last summer, in Europe, that he had made unforged gun-metal that, theoretically, was as strong as any forged steel he knew, and that he believed he could make a safe gun of it; but he did not believe it capable of such high ballistic power as forged steel ordnance was capable of obtaining; and, further, if he were Director-General of Artillery, he would consider it a criminal act on his part if he gave orders for its production and issue to the service.

I would like to add here that the vigorous attacks made during the past year in England have been upon the system of supply, poor material, bad design, individuals, conservatism, and absence of suitable, intelligent experiment. But nowhere in this prolific literature can there be found any demand for poorer, cheaper material to replace the characteristics that for so long have been too low instead of too high. On the contrary, one of the accusations of the English press called attention to the low characteristics, intimating that they were laid down for the special benefit of one firm, to be altered from time to time as that firm's production improved.

I do not agree entirely with the writer of the article on "Modern Artillery," from which I have quoted the above passage. As far as Sir Joseph Whitworth and Co. are concerned, it must be remembered that it is only within a limited period that this firm has received any orders for finished guns, and there is nowhere on record the bursting of any British gun manufactured of their material. In regard to design, I have some information which justifies me in saying that this firm's protest against the insertion of the liners in two parts in the guns under manufacture by them for the British Government caused the War Office to alter their designs in this important feature, at least as far as the contract with Sir Joseph Whitworth and Co. was concerned.

The steel we want for guns cannot be described by either of the terms "mild" or "hard" which Mr. Dorsey has employed. It must be tough and elastic, and manufactured with the greatest intelligence and care, from the selection of the charge to the finishing of the gun. There must be nothing "cheap" about it, no uncertain or inadequate treatment. Such steel as we want exists abroad, and is fabricated into guns that have not and will not burst before a long life has been reached. It has already been made in small quantities in this country,



and, as the demand increases, will soon be manufactured in larger masses.

In regard to the material of which the guns that have burst in England were made, it must not be forgotten that of the material in the Collingwood gun, the committee said there was a want of uniformity and proper treatment. My inquiries of the chairman of Krupp's administration brought forth an absolute denial of the statement of Colonel Hennebert relating to the disabling of German guns at the siege of Paris, afterwards quoted by the Duke of Cambridge. But even admitting that thirty-six German guns were disabled, the result of the struggle between the two powers was sufficiently definite to point out what splendid work the remaining ones accomplished.

The failures to which Mr. Dorsey has referred prove that poor steel of any physical characteristics is no more fit for guns than was the inferior steel for their purposes that the civil engineers used for structures, and which reflected so seriously, but falsely, upon the use of steel as a superior material to iron. I claim that the failures of the steel guns in England (I suppose them to be the ones to which Mr. Dorsey refers) resulted from causes entirely distinct from those that he imagines them to be. By no journal has this matter been more thoroughly and ably handled than by the London Engineering. This paper, edited by men of high technical ability, is an advocate of the opinions and work of a large number of British mechanicians. As you all know, and have probably read, there have appeared exhaustive reviews of the sad condition of England's gun supply. Severe as these attacks have been upon administration and methods, all the articles have demanded more powerful ordnance and better material.

I believe that Captain Michaelis, of the Ordnance Corps of the Army, is the only military engineer who quotes the essayist to any great extent; while in the Navy there also remains one isolated example, who has stated that he is "firmly convinced that the gun of the future, both for sea coast and afloat, will be a steel cast gun." Against the opinions of such names as Dorsey, Michaelis, Metcalf, Thurston, Howe, Evans, William P. Hunt, Haskell, and Wiard (who advocate cheap material of one kind or another), I feel myself on very solid ground in accepting the work of Whitworth, Schneider, Krupp, Vavasseur, Kolokoltzoff, Simpson, Fritz, Leavitt, Joseph Morgan, Jun., Davenport, and Birnie, and hope I may be allowed the benefits of their advice and guidance for many years yet to come. If the former are content to remain where Rodman brought the ordnance problems, the latter are not; and I am confident were General Rodman alive to-day, he would be as firm an advocate of forged, oil-treated steel of high physical characteristics as either Krupp, or Whitworth, or Schneider. I look upon the persistent attempts to keep gun construction where Rodman left it, which have had so much influence in blocking progress in the Army, as a reproach to his memory and to his attainments.

Sometimes the minority is right, but there appears to be no chance for it in this case; for if forged steel, built-up guns are not the best, there has been ample time since 1843 to discover the mistake. Instead, however, of there being a shadow of a doubt as to their superiority, every fighting power on the face of the earth has accepted a steel of the characteristics Mr. Dorsey condemns. Mr. Hewitt's answer to an advocate of cast-iron ordnance—"Of course you are aware that you have the judgment of every military engineer against you"—applies well to the essayist's theories; and, further, not only is the judgment of every military engineer against them, but there is added thereto the weighty judgment of the most eminent steel manufacturers of the land, the majority of whom, I am informed, have not only not been consulted by the essayist, but have never even heard of him.

Before closing I desire to call the attention of all the members of the Institute to the pleasure I have had, during my recent visit to Europe, to hear on every side such honourable mention of the work this Institute has done, and the esteem with which our worthy President, Admiral Simpson, is held by the military scientists of the old world as well as the new.

These facts, added to the honour and merit that have been conferred in complimentary notices by the foreign press, should be most gratifying incentives for its further development.

American Bridge Building.—The St. Louis Bridge and Iron Company is building a highway bridge 175 ft. span for Lincoln county, Missouri; and one of 180 ft. span, and one of 110 ft. span for Jefferson county, Missouri. The company has also contracted for a number of smaller bridges.

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SHIPS, &c.

11,266. J. Chaffaud and J. H. Konter, Marseilles, France. Water Brake for Stopping Ships or Aiding in Steering. [8*d.* 2 *Figs.*] September 22, 1885.—Inventors claim that by the application of this invention a single person in charge of a steam winch working three chains running through hawseholes fixed on the inside hull and attached to two wings or flaps placed one at each side of the vessel, may, by slackening the chains, allow the flaps to be forced open by springs fixed on the inside hull, and thus diminish speed and stop the vessel. (*Sealed November* 26, 1886).

15,049. J. Wright, Tipton, Staffs. Improvements in Anchors. [8*d.* 5 *Figs.*] December 8, 1885.—This invention relates to that class of anchors in which the crown arms or fluke-pieces are made capable of turning in the head of the shank, and the improvements consist in making the anchors with a larger bearing suface for the arrestment of the crown arms at their proper angle. (*Sealed December* 14, 1886).

15,167. G. D. Davis, London. Improvements in Machinery for Controlling Rudders of Ships. [8*d.* 5 *Figs.*] December 10, 1885.—The improvements comprise a band or surface acting on a wheel or enlarged part of the rudder head, so as to hold or put restraining friction on it by compression against a fixed block or part. (*Sealed November* 26, 1886).

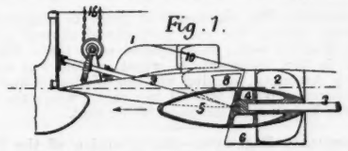
15,231. J. Blenkinsop, Albrighton, Salop. An Insulating Medium for Protecting Iron and Steel Ships' Plates from the Corrosive or Electro-Galvanic Action set up between the Plates and Materials Used in Anti-fouling Compositions. [6*d.*] December 11, 1885.—The insulating medium consists essentially of zinc in a finely divided state with a quick-drying varnish capable of employment under water. (*Sealed December* 21, 1886).

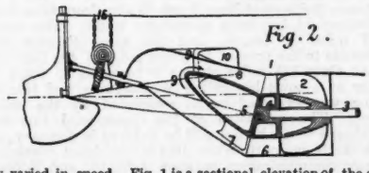
15,883. A. F. Yarrow, London. An Improved Arrangement for Launching Torpedoes. [6*d.* 3 *Figs.*] December 24, 1885.—The improved arrangement consists in arranging the launching tubes in groups of two or more, so that when the torpedoes are fired the paths taken by them will cover an extended area, and thus obviate uncertainty of aim. (*Sealed December* 31, 1886).

15,884. A. F. Yarrow, London. Improvements in the Mode of Supplying Air to Steam Boilers for Torpedo and other similar Vessels. [8*d.* 2 *Figs.*] December 24, 1885.—The air is forced by a fan into the stokehole compartment whence it is forced to the smokebox end of the boiler, where it is passed over heating tubes and whence it is returned and supplied to the furnace in a highly heated state. (*Sealed December* 24, 1886).

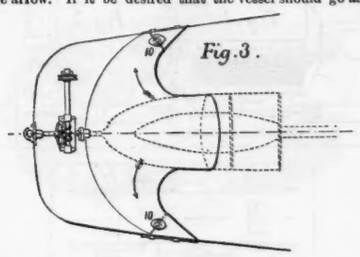
393. H. M. Bennett, Bournemouth, Hants. Improvements in Torpedoes, and in Adapting the Same for Communicating with Vessels in Distress. [11*d.* 16 *Figs.*] January 9, 1886.—This invention relates to the employment of ordinary fish torpedoes similar to those used in naval warfare except that they do not carry any explosive charge; telephone and life-saving lines being towed by the torpedo, whilst provisions, life-saving jackets, &c., are stowed in the chamber generally reserved for the explosive charge. The torpedo is steered by steering gear actuated by its propelling engines, and controlled by electric currents transmitted through a conductor towed by the torpedo. The propelling engines of the torpedo are automatically stopped upon its striking a ship. (*Sealed December* 31, 1886).

578. J. I. Thornycroft, Chiswick, Middlesex. Improvements in Propelling and Steering Apparatus for Ships or Vessels. [11*d.* 5 *Figs.*] January 13, 1886.—This invention relates to a combination of a propeller with a steering or "rearward body" described in Patents No. 1330 of 1879, and No. 1853 of 1881 of the same inventor. The present invention has for object to enable vessels fitted with propellers of that kind to go astern, and give them manœuvring qualities independent of endwise motion, the propelling engines not being reversed but



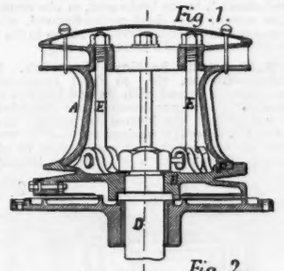


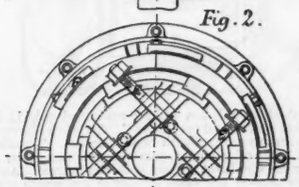
only varied in speed. Fig. 1 is a sectional elevation of the stern portion of a vessel provided with propelling and steering apparatus according to this invention, set for going ahead. Fig. 2 is a similar view, with the apparatus set for going astern. Fig. 3 is a plan view showing the curved water passages. 1 is the hull of the vessel; 2 is a screw propeller secured to the driving shaft 3. Behind the propeller is a rearward body formed in two parts, of which the one part 5 is pivotted in the part 4. 6 is a tube encircling the propeller 2 and the part 4 of the rearward body. The part 4 is connected to the tube 6 by guide plates 7, which serve to gradually deflect and direct the water projected from the propeller in a direction approximately parallel to the axis of the fixed part 4 of the rearward body. The part 4, the guides 7, and the tube 6 are rigidly connected to each other and to the vessel 1. The part 5 is rigidly connected by plates 8 to a curved plate or cover 9 which when in position shown in Fig. 1 forms a continuation of the hull of the vessel, and closes the inlet orifice common to the connected curved passages 10, 10 (Fig. 3). When going ahead the several parts are in the relative position shown in Fig. 1. The stream of water from the propeller 2 is caused to pass rearward through the tube 6 in the direction of the arrow. If it be desired that the vessel should go astern,



the connected cover 9 and part 5 of the rearward body are rotated on their common axis through half a revolution by operating the chain 16, so that they assume the position shown in Fig. 2, when the opening in the under part of the vessel's hull is uncovered. The stream of water from the propeller which continues to rotate in the same direction, will pass rearward through the tube 6 as before, but it will now be deflected and guided by the combined cover 9 and part 5 in the direction of the arrows (Figs. 2 and 3), so as to pass through the curved passages 10, 10, in a forward direction at a more or less acute angle with the keel of the vessel, and by its reaction will cause the vessel to move astern. (*Sealed January* 21, 1887).

1876. W. Clarke, Gateshead-on-Tyne, Durham. Improvements in Warping and Anchor Capstans. [8*d.* 4 *Figs.*] February 9, 1886.—According to this invention a capstan barrel may be readily removed and replaced. On the upper face of the capstan spindle D is fixed a disc B fitted with pawls, and provided with recesses to receive the projections of the barrel A. The upper face of the disc B is furnished with lugs to which are secured bolts E that pass up through the

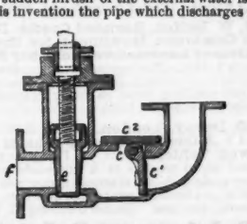




head of the capstan barrel which is thereby firmly secured to the disc, the strain of the rotary pull of the warp being borne by the projections engaging into the recesses. To remove the barrel A it is only necessary to remove the nuts from the bolts, when the barrel may be at once lifted off, or the holes through the capstan head may be slotted, so as to allow the bolts to fall inwards when the nuts are slightly eased back, thus releasing the barrel. Fig. 2 is a plan of the capstan with the barrel removed and the bolts E turned down. (*Accepted December* 10, 1886).

4758. E. Hunt, Glasgow. (*J. Scotland, St. Pierre, Miquelon.*) **A Twist Indicator for Ships' Cables.** [8*d.* 2 *Figs.*] April 6, 1886.—The twist indicator comprises a magnet fixed on a vertical arbor which is free to rotate, and which is connected by toothed gearing with one or more index pointers arranged to move over a dial or dials showing the number of turns or twists in the cable. (*Sealed November* 26, 1886).

10,354. B. Haley, London. Improvements in Valves Used on Board Ships. [8*d.* 3 *Figs.*] August 12, 1886.—This invention relates to what are known as storm valves used on board ships by which water, &c., is discharged through the ship's side, whilst any sudden inrush of the external water is prevented. According to this invention the pipe which discharges into the sea



at *f* has an opening *e* which is closed by a cover c^2 bolted to it. This cover carries a suspended flap valve c^1 which hangs upon a seat formed on the pipe. A separate sliding valve *c* is provided, so that by shutting down this valve, the cover c^2 can be opened and the valve c^1 removed even when the opening *f* is under water. (*Sealed December* 21, 1886).

12,648. J. A. Benninger, Louisville, Kentucky, U.S.A. Preventing Vessels Sinking. [8*d.* 4 *Figs.*] October 5, 1886.—This invention relates to the employment both outside and inside a vessel's hull of a system of collapsible bags or buoys, all communicating by means of pipes with a common reservoir containing a gaseous element in a highly condensed or compressed state; the pipes being provided with valves for regulating the flow of the gas to the bags. (*Sealed January* 11, 1887).

12,674. C. P. Wetherill, Woodville, Mississippi, U.S.A. Improvements in Screw Propellers. [6*d.* 3 *Figs.*] October 5, 1886.—Inventor claims a screw propeller or propelling wheel having its blades of suitable pitch set inclining in the direction of their length relatively to the axial line of the shaft of the wheel and forwardly in the direction of the motion ahead produced by the propeller, the plane of the inclination of the blades crossing the axial line of the wheel shaft. (*Sealed January* 11, 1887).

RAILWAY PERMANENT WAY.

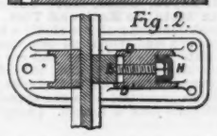
14,801. W. P. Stewart, Blackwood, Mon. Improvements in Combined Tie-Bars and Chairs for Tramways and Railways. [6*d.* 4 *Figs.*] December 2, 1885.—According to this invention the chairs are cast upon the heated, scored, cut, or roughened ends of the wrought-iron tie-bars. (*Sealed December* 21, 1886).

15,623. B. Rathbone, Liverpool. Improvements in Permanent Way of Railways and Tramways. [6*d.* 5 *Figs.*] December 19, 1885.—The improvements relate to metal cross sleepers of novel construction. Each sleeper is composed of two sides at right angles to each other. The sleeper is placed with the right angle or apex resting on the roadway in ballast, and the rails are carried on the free upper edges of the sleeper. Triangular bearing blocks of wood which fit in the sleepers, may be secured to the latter by bolts, the rails being attached to the bearing blocks by bolts or clips. (*Sealed December* 28, 1886).

661. W. Dickinson, Morley, and J. Hibbert, Bradford, Yorks. Improvements in Means or Apparatus for Securing Rails in Railway Chairs. [6*d.* 1 *Fig.*] January 15, 1886.—Inventors claim the arrangement, construction, and application of a metallic block roughed on the face or provided with projections in combination with wood packing applied within the ordinary chair. (*Sealed January* 21, 1887).

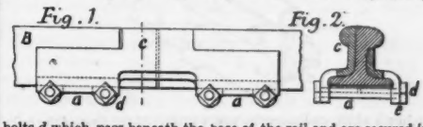
687. J. Rebla, Morley, Yorks. Improvements in Keys or Wedges for the Fastening of Railway or Tramway Lines to the Chairs. [8*d.* 8 *Figs.*] January 16, 1886.—A small metal key or wedge fitting into a recess formed in a larger key or wedge or ordinary wooden block has one of its ends bent round the jaw of the chair for the purpose of preventing the keys or wedges from becoming detached. (*Sealed January* 25, 1887).

1360. B. Rhodes, Bradford, Yorks. Improvements in the Construction of Railway Chairs. [6*d.* 6 *Figs.*] January 30, 1886.—One side of the chair is formed to fit the rail, whilst the rail is held on the opposite side by a metal block E



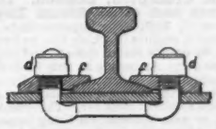
which is guided between flanges D, D^1 formed on the chair. The block E is pressed tightly against the rail by means of a screw G, the head of which is locked by a cap H held in its position by grooves on each side fitting on suitable projections. (*Accepted December* 7, 1886).

2968. H. F. Dale, London. Improvements in Rail Joints or Fastenings. [6*d.* 3 *Figs.*] March 2, 1886.—This invention relates to fastenings for securing together the abutting ends of rails in an effective manner whilst allowing them to expand or contract under atmospheric influences. This holding is effected without drilling the web of the rail. The plates A, A extend below and under the base of the rail B, and nearly meet in two or more places. The two plates are secured together by



bolts *d* which pass beneath the base of the rail and are secured in underhanging lugs *c*. A portion of the two abutting ends of the rails B is cut out, and this space is occupied by a solid piece of metal C which forms part of the plates A on one side of the rails and connects the two rail heads so as to serve as a bearing for the wheel and prevent it from striking abruptly against the whole edge of the end of the rail. This invention is also applicable to double-headed rails. (*Accepted January* 5, 1887).

10,402. A. B. Ibbotson, Sheffield. Improvements in and Relating to Fastenings for Securing Railway Rails upon their Sleepers or at their Joints. [8*d.* 18 *Figs.*] August 13, 1886.—This invention relates especially to the employment of an improved double bolt or fastener *d d*, consisting of two parallel screw-threaded shanks connected by bent or curved corner portions with a crossbar. The bent corner portions are



depressed below the bearing surface of the crossbar, so that they do not bear against the sleeper or fishplate, and therefore no countersinking of the holes or cutting away of the metal at the sides is necessary. The rail is secured to the sleeper by means of the improved double bolt in combination with plates or washers *f* which bear upon the flange of the rail. The bent corner portions impart considerable elasticity to the bolt, so that after the nuts are tightly screwed up, the bolt is not liable to become loose by the ex-

pansion of its shanks. When the improved double bolt is employed for securing rails at their joints, the shanks are passed through holes in the fish-plates and the rail, and the nuts are then screwed upon them. To prevent the falling of the double bolt when the nuts are taken off, the bolt may be secured to the sleeper by means of a set-screw inserted through the crossbar of the bolt. (*Accepted December* 17, 1886).

10,548. N. P. Davison, London. Improvements in Railways, and in Engines and Carriages therefor, and in Means and Appliances for Propelling the Same. [6*d.* 5 *Figs.*] August 17, 1886.—This invention relates chiefly to means for securing rolling stock while travelling at high speed, and preventing it from leaving the rails. With this object the railway is constructed of a box form, and preferably of light open ironwork. Each line is provided with four rails, two under the carriages as usual, and two overhead; the carriages being fitted with wheels to correspond. (*Sealed November* 26, 1886).

11,369. A. J. Boult, London. (*H. H. C. Sintzenich, Toronto, Canada.*) **Improvements in Chairs for the Permanent Way of Railways.** [6*d.* 5 *Figs.*] September 7, 1886.—Referring to Fig. 2, the chair A is shown shaped to fit one side of the rail B, forming a solid clutch *b* on that side. The other side of the rail is held by a movable clutch *c* secured by a single

Fig. 1.

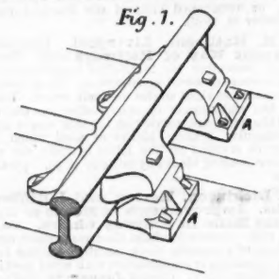
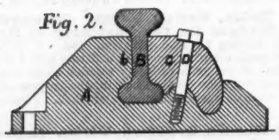


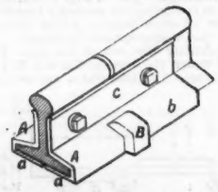
Fig. 2.



screw bolt D, and so fitting the chair that the lateral thrust caused by the pounding of the wheel flange against the inside of the rail-head, is received by the solid chair A, and will not cause any strain on the bolt D. No bolt holes are made in the rail. The chair is secured to the sleeper by preferably three bolts. Fig. 1 is a perspective view of a double chair A A designed according to this invention. (*Sealed December* 24, 1886).

12,381. C. H. Sayre, Utica, New York, U.S.A. Improvements in Metallic Railroad Ties. [8*d.* 11 *Figs.*] September 29, 1886.—Inventor claims chiefly a metallic railroad tie rolled or forged in a semi-cylindrical form with two projecting lips forming fish-plate joints perforated and cut from the central portion of the tie, and bent upward and inward to engage the opposite sides of the rail for securing the rail ends, with means for holding the two lips in contact with the opposite sides of the rail whereby a fish-plate joint is formed. (*Accepted November* 2, 1886).

14,695. A. J. Boult, London. (*J. Swann, New York, U.S.A.*) **Improvements in Combined Fish-Plate and Chair and Rail Fastener for Railways.** [6*d.* 4 *Figs.*] November 12, 1886.—A, A are duplicate metallic plates, two of which are used to make one support or connection for the rails. Each plate consists of a vertical portion *c* abutting closely against the web of the rail and thus forming the fish-plate; of the side



incline *b* which embraces the upper surface of the base of the rail; and of a lower horizontal portion *a* which extends from the outer edge of the rail to the centre of the base of the rail, and thus constituting one-half of the chair. The two plates A, A, are secured rigidly together by bolts, which also pass through the web of the rail. This combined fish-plate and chair is secured to the sleeper by means of flanged spikes B. (*Accepted December* 17, 1886).

RAILWAY ROLLING STOCK.

12,841. M. Schleifer, Berlin. Improvements in Brakes. [1*s.* 3*d.* 18 *Figs.*] October 26, 1885.—The present invention relates to further improvements in brakes for railway carriages in addition to those described in Patent No. 14,575 of 1884, and extends to those parts which are requisite for the operating of the brakes. (*Sealed November* 12, 1886).

14,021. T. R. Crampton, London. Improvements in Locomotives and other Steam Engines. [8*d.* 10 *Figs.*] November 17, 1885.—The improvements relate especially to that class of steam engines in which the power is conveyed to the shaft or axle by cranks placed close to and opposite each other at an angle of 180 deg. According to this invention the cylinders are placed one behind the other, not centrally in a line, but so that the piston-rod of the rear cylinder may pass as closely as may be alongside of the foremost cylinder. The cranks may be at one end of the shaft or axle without its being necessary to employ bearings on both sides of the cranks. Fig. 3 is a plan view of a locomotive engine having two pairs of driving wheels, each pair being driven independently by two cylinders arranged as above explained. The power from each pair of cylinders E acting in opposite directions is conveyed by connecting-rods through the nearest driving wheel H nearly direct to the rails, whilst the other driving wheel H' at the opposite end of the axle receives its power through the whole length of the axle by torsion acting in one direction only, thereby avoiding the alternating torsional effects produced in ordinary engines. The exhaust from both pairs of cylinders may be made to pass through separate chimneys P, P, as shown in Fig. 2—in this case the smoke-box is divided by a vertical partition. The whole of the space between the two axles is available for boiler purposes. The grate R is extended below the whole length of the boiler, which assumes the form of an ordinary marine boiler. The grate may be fed from either or both ends. In Fig. 1 the firebox is fed from the chimney end. With this construction the driver is able to see to the four axle-boxes V through openings made in the footplate. Fig. 4 illustrates a method of moving the locomotive a short distance so as to move the engines off their

Fig. 1.

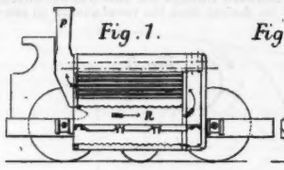


Fig. 2.

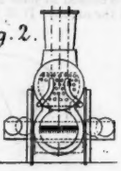


Fig. 3.

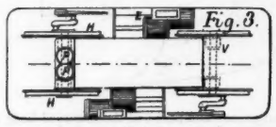
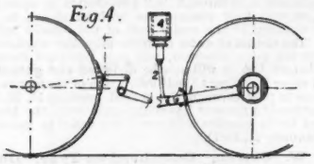


Fig. 4.



dead centres. The pawl 1, when carried round in one direction by a lever 2, grips the flange of the wheel and turns the wheel round, but allows it to continue to revolve freely in the same direction if the cylinders of the engine commence to drive the wheels. The lever 2 may be actuated by the piston-rod of a steam cylinder 4. The same cylinder may be used for brake purposes, it being merely necessary to disconnect the piston-rod from the pawl gear and attach it to the brake gear, or *vice versâ*. This can be effected, as shown, by a short connecting-rod, which can be swung into position either to connect the piston to the brake lever or to the pawl lever. (*Sealed January* 21, 1887).

15,014. H. K. Austin, Saltley, Warwick. Improvements in Axle-Boxes. [8*d.* 40 *Figs.*] December 7, 1885.—The axle-box casing is formed with its end inclined at an angle to the bottom of the casing to accommodate the lubricator, and carried up and around the journal to prevent the lubricant escaping. The lubricator B is retained in place by two partition walls W which are serrated on their upper edges to give passage to the lubricant. These partition walls extend longitudinally the

Fig. 1.

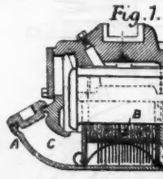
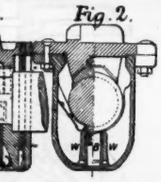


Fig. 2.



whole length of the axle-box and are continued outside the front end of the box as a curved projection C. The lubricator consists of a pliable steel frame covered with folds of cotton. Threads dipping into the oil in the oil chamber, pass through the folds, and have their upper ends in direct contact with the journal. An elliptical spring tends to press the whole lubricator B upwards against the underside of the journal. This spring is rivetted to the lubricator B, and is hooked at its outer end to enable the lubricator to be readily withdrawn. (*Sealed January* 14, 1887).

15,169. W. H. Kitson, Kirkstall, Yorks. Improvements in Railway and Tramway Wheels. [8*d.* 10 *Figs.*] December 10, 1885.—This invention has reference to a construction of elastic compound wheel. The wheel body or centre is of iron or steel, and has formed in its periphery a number of transverse slots or recesses into which blocks or cushions of wood are forced so as to project somewhat beyond the periphery of the wheel centre, and to take a firm bearing against the inner circumference of the tyre which is secured to the wheel centre by a flanged ring or other suitable means for preventing lateral displacement of the cushioning blocks. (*Sealed December* 14, 1886).

15,790. J. Hodgkins, Warwick. Independent Wheel Attachment for Railway, Tramway, and other Cars. [8*d.* 5 *Figs.*] December 23, 1885.—The independent wheel attachment consists of a cylindrical sleeve running freely on the axle, and forming one of the axle journals, and to which sleeve one of the wheels is fixed, for the purpose of enabling flanged wheels to run round curves without any liability to run off the rails, and with the least possible amount of friction on the flanges of the wheels. (*Sealed November* 26, 1886).

2924. M. W. Bullen, Barnard Castle, Durham. An Improved Combined Movement for the Steam and Brake Valves of Locomotive and other Engines. [8*d.* 1 *Fig.*] March 1, 1886.—The improvement consists in the freeing of the brake valve at a certain point in the combined movement from any strain resulting from its being coupled to the steam valve. (*Sealed December* 31, 1886).

12,680. O. Imray, London. (*J. G. Hill, Flatbush, New York, U.S.A.*) **A Construction of Wheels for Railway or Tramway Vehicles.** [6*d.* 2 *Figs.*] October 5, 1886.—The improved wheel consists of a rim made with an internal flange, a nave made with an external flange, and a pair of plates each made with an annular corrugation, and both rivetted to the flanges of the rim and boss. (*Sealed January* 11, 1887).

14,413. C. Zacharias and H. Zacharias, Vienna. Improvements in Smoke Consumers for Locomotive Boilers. [6*d.* 3 *Figs.*] November 8, 1886.—The improved smoke consumer consists of two air supply tubes *a*, *a*, arranged beneath both longitudinal borders of the grate *b*, thence extending upward through its rearmost portion, running up the lateral sides of the firebox in a zig-zag line, and ending in a chest or box *c* fixed to the rear end of the firebox above the firedoor *d*. This box *c* extends horizontally across the firebox, and is provided with a horizontal slot formed by lips having a downward direction. The open lower ends of both the pipes *a* are directed forward, and are provided with shut-off flap valves *f* mounted on a common shaft *g*, which may be partially rotated in either direction by means of a

Fig. 1.

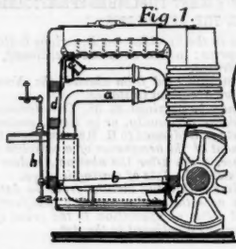
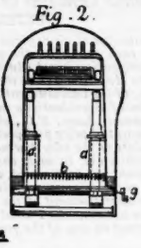


Fig. 2.



system *h* of cranks and connecting-rods, so that by turning the shaft the supply of hot air to the flame can be controlled. The prevailing draught will constantly cause a current of air to pass through the heated pipes *a* into the chest *c*, whence a sheet of hot air will continuously stream into the fire and burn the imperfectly oxidised gases, as well as the small particles of carbon carried along by the draught. (*Accepted December* 31, 1886).

TRAMWAYS.

12,230. M. H. Smith, Halifax, Yorks. Improvements in Collectors for Electric Tramways. [1*s.* 3*d.* 24 *Figs.*] October 14, 1885.—The improved collector consists of a frame or trolly formed with ploughs or clearers connected to the main portion of the collector frame by flexible bands which are secured by pins or plates connected by hinges, for the purpose of enabling the collector to readily adapt itself to curves in the line of the channel. (*Sealed November* 9, 1886).

241. R. C. Parsons, Leeds. Method of Rendering Invisible the Escape Steam of Tramway and other Road Locomotives. [4*d.*] January 6, 1886.—The escape steam is rendered invisible by enlarging when required the area of passage through the boiler tubes so as to admit increased heat to the smokebox. (*Sealed January* 11, 1887).

327. A. Greig, London. An Improvement in Tramway and other Locomotive Engines. [6*d.* 1 *Fig.*] January 8, 1886.—According to this invention both the axles of two pairs of road wheels are driven from an intermediate wheel which is driven in its turn by a pinion on the crankshaft of an engine mounted on the top of the boiler. (*Sealed January* 7, 1887).

649. T. Archer. Dunston, Durham. Improvements in the Construction of Tramcar Wheels. [8*d.* 4 *Figs.*] January 15, 1886.—According to this invention an easily interchangeable partly chilled and partly soft tyre is attached to a permanent wheel body by means of a projecting flange overlapping the rim of the wheel itself, and bolts passing through both. (*Sealed January* 21, 1887).

1438. C. D. Norton, London. Improvements in Tramway and other Rails. [6*d.* 2 *Figs.*] February 1, 1886.—The object of this invention is to enable the worn parts of the rails to be removed and replaced by new ones without disturbing the roadway so much as heretofore. The rail consists of a ⊥-shaped bottom part and a top or head with the ordinary tread or groove. The two parts are dovetailed one into the other, and are firmly held together by double hooks secured by wedges. (*Sealed January* 4, 1887).

12,584. J. Smith, Wednesbury, Staffs. Improved Device for Removing Obstructions from the Front of Tramway Engines. [6*d.* 5 *Figs.*] October 4, 1886.—The improved device consists of a flap hinged to the front plate of the engine. (*Sealed January* 11, 1887).

TRACTION ENGINES.

13,427. W. Hornsby and R. Edwards, Grantham, Lincoln. Improvements in the Construction of Bearings for the Shafts of Portable and similar Engines to Allow for Boiler Expansion. [6*d.* 4 *Figs.*] November 6, 1885.—According to this invention the plummer-blocks are provided with trunnions which can slide in suitable bearings attached to standards that are fastened to the boiler; the plummer-blocks being rigidly attached to the cylinder or other end of the boiler by suitable rods. (*Sealed November* 19, 1886).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

MONTREAL.—The shipments of grain to Europe from Montreal during the year just closed showed an increase of 40 per cent., as compared with 1885. The increase in the shipments of wheat, which was almost entirely American, arriving *vid* the Welland Canal and St. Lawrence routes was 64 per cent., while the shipments of Indian corn increased 90 per cent.

AUSTRALIAN RAILWAYS.—An extension of the Great Northern Railway of New South Wales, from Glen Innes to Tenterfield, has been opened for traffic. The section is 57 miles in length, and the total distance from Newcastle to the present terminal point of the line is 381 miles. Only 11½ miles of line is required to reach the border at a township called Wallangarra, and this last section was expected to be completed by the end of March. The extension of the Queensland line from Stanthorpe to the border will be finished in January, and when the New South Wales line is completed continuous railway communication between Adelaide and Brisbane will be established, with the exception only of a break which will be made good by the Hawkesbury River Bridge now in course of erection. A scheme is afloat for the construction of a railway from the nearest port in Western Australia to cross the continent to Victoria or New South Wales. Mr. J. J. Clarke, who is at present in Adelaide, intends to proceed to Western Australia in connection with the scheme.

MANUFACTURE OF PIPE FITTINGS IN THE UNITED STATES.

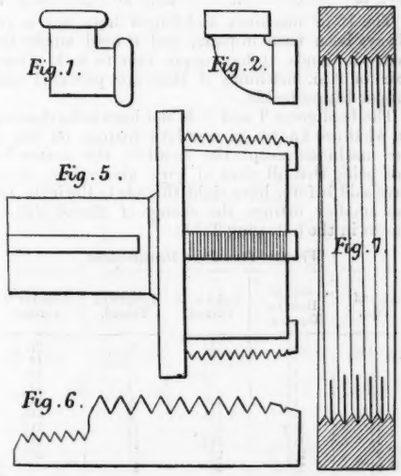
By W. D. FORBES, M.E.

WITHIN the last thirty years, there has grown up in the United States an industry in which is invested many millions of dollars, employing thousands of men, and yet the business may be said to be the performance of but one mechanical operation, which in itself is a very simple one, *i.e.*, the screwing or tapping of holes in metals,

On first thought, tapping fittings would seem to present no very great difficulty, or require much if any ingenuity, but it must be borne in mind that the very simple mechanical operation of tapping a few holes, of small diameters, without much regard to expense, is vastly different from performing the same work, at little cost, in holes requiring quite a degree of uniformity of diameters, and as large as 6 in., 8 in., or even 18 in. Beginning with the laying on of water in private dwellings, followed by the adoption of gas as an illuminator, and the petroleum discoveries, and later by the use of natural gas, the fitting industry may be said to be a naturally born offspring which has been nursed by no artificial means, but gathering strength from natural, healthy sources, till it promises to-day to be nowhere near full grown, despite its wonderful size.

The fittings used to-day on large water pipes are similar to those made forty years ago, and the system of ball and spigot ends and cast-iron pipes, is also in use for gas mains. As this style of connection is widely known and old, nothing further need be said on the subject except to mention that of late a method of using a ring of lead, which is forced into place by hydraulic pressure instead of running the molten metal into position and then caulking, is being used with satisfactory results, as a great saving of time and lead are effected.

The earliest fittings were invariably made of brass, which material was superseded by malleable iron, and this, in turn, gave way to cast iron, for general use, although malleable is still much in favour in the gas-fitting trade. The brass articles were made with square elbows like Fig. 1, the holes in them drilled, not cast, and the screw threads were chased by hand in an ordinary brass-finisher's



lathe. Half an inch was for some time the maximum size, and the output of one man in ten hours was not over 100 elbows at best. Coring out the holes in fittings, and the change from square to round corners, like Fig. 2, were changes naturally made at the same time. As at first no standard for threads or sizes existed, sizing taps were not thought of, but the tubes or pipes, being mostly brass, were chased to meet the threads of the fittings.

As the demand increased, manufacturers began to vie with each other, and the first changes from brass to malleable iron was the result of a desire to economise in material and not on any claim of superiority. The fact that in chasing a fitting it had to be taken from the lathe chuck in order to present the several holes to the tools, caused much trouble, as in so doing it was almost impossible to get all the three holes of a tee, or the two of an ell, in the same place and at right angles to each other. To overcome this difficulty the first step taken was toward special tools for the fitting business. Fig. 3 shows a swinging or revolving chuck, the jaws of which on being tightened on the fitting, were capable of revolving, thus permitting the screwing of all holes in the same plane, and, if the chuck was properly divided, at right angles to each other. Fig. 3 shows a chuck of modern construction possessing advantages which earlier ones did not have. The

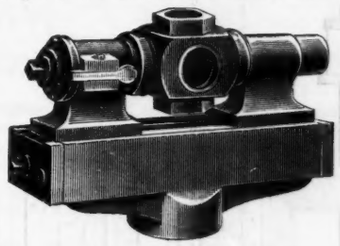


FIG. 3.

main difficulty with any system where the work revolved arose when malleable iron came to be worked, as it required a lubricant, which brass did not, and to keep the same where it was wanted was impossible, as the tendency was, of course, to fly from the tap. To meet this a change of system was resorted to, and the tap was made to revolve while the fitting remained stationary, and no further trouble in lubricating was encountered. It is evident that by this change a great saving of time was made, as the machine driving the tap, which was a simple drill press, did not have to be stopped and started, or

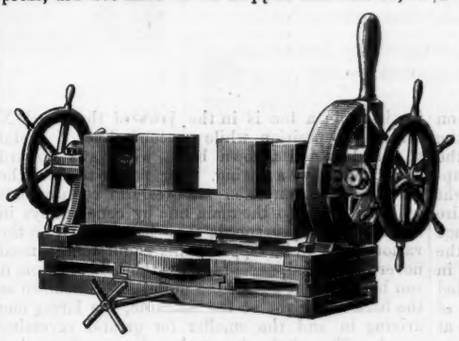


FIG. 4.

remain idle on each new fitting being chucked. The swing chuck was modified when used under a drill press, and Fig. 4 shows the modifications made. In making fast the chuck to the platen it was, of course, prevented from turning, but it was found advantageous to permit a slight movement around the centre line of the tap; this allowed the fitting, in which the cast hole was a little out of centre, to tap a full thread, which would not be the case if the chuck was perfectly rigid.

It was for a long time considered absolutely necessary to ream all fittings before tapping, but to-day it is never done, nor is it in the least an advantage, as was proved by a set of experiments, made by the writer, to ascertain if by reaming any tighter joints were made, or whether tapping the unreamed hole in any way weakened the screw threads. No noticeable advantage was gained by either method, except saving of expense by not reaming.

On a single spindle tapping machine about 1000 holes of $\frac{3}{4}$ in. pipe can be got out, and their use to-day is limited to making bushings, flarges, unions, and all single-hole articles. It was necessary to reverse the tap when it had entered to the proper depth, and even with a reverse speed of four to one much time was lost, and great efforts were made in the early days in the fitting business, to make a reliable "collapsible tap" to overcome this loss. These tools were designed to permit the chasers to be drawn towards the centre of the tap, so that when the work was done it could be lifted out of the fitting, the chasers again expanded and a new hole tapped. Ingenious as were these attempts, all have proved failures for commercial use, and to-day the large manufacturers have abandoned their use. The trouble was that the standard size could not be depended upon, as a very slight amount of grit working in behind the chasers would make enough variation to be noticeable. The very severe duty called upon to be performed by a tap precludes the idea of any but the most rigid construction, and with all the loss of time in reversing a gain of work done was found by the use of solid taps. When fittings were not larger than 1 in. or even 2 in., how to make the tap for them was not a question of moment, but when larger sizes were required, it became a question of great importance; as to get steel of proper quality and size was difficult, and the danger of poor results in hardening after much labour had been expended was too great. Many methods were tried, but the simplest and most successful way is as described in the patent of Mr. John Strong. No patents were taken out by him in foreign countries.

The tap consists of a cast-iron body of proper shape and size like Fig. 5, in which are planed slots, the bottoms of them being at an angle from a line drawn through the centre of the body. In these are fitted chasers or bits like Fig. 6 (which is enlarged). These, it will be noticed, have threads of proper pitch for the size of fitting, and also a finer thread chased on the back end or a shoulder which also tapers. The chasers being inserted the ring is screwed into them, and the threads for the fitting are then cut. After being relieved, or "backed off," and hardened, they are replaced, and having been worked as described it is evident each chaser must, when the ring is screwed on, takes its proper relative position as when chased. To adjust these taps the ring is backed off a little, and the chasers are driven back, which, as they bottom on a taper, enlarges of course the tap; the ring is then screwed up tight, and all is ready for use. The adjustment possible is about $\frac{1}{8}$ in. At first the number of chasers were always odd, and a 4 in. tap had five or seven, but gradually the practice has settled down to four on all sizes, and a set that the writer is now making in his works for 24 in. fittings have but four. As a Table will be given later of standard threads, tapers, and sizes of American fittings, with the new standard lately adopted by the tube-makers, nothing further need be said here on the subject. On the discovery of petroleum in Western Pennsylvania the manufacture of fittings was given an immense impetus, and the numbers used taxed the makers' slender resources to their utmost. The sizes at once jumped from a maximum of 2 in. to 4 in., and very shortly to 6 in., and it was imperative that better means than engine lathes for the work should be provided. To chase the threads on an engine lathe made the cost of large fittings too great, but the proposition that a 6 in. hole could possibly be tapped caused much merriment. As has been the custom for years, New England seems to have been called upon to settle the question, and to furnish the ideas and machines for this work, and strange as it may seem, the East to-day furnishes a greater part of the goods for the oil-field market despite the distance and cost of transportation. Just who designed the first of the now used "three-way tappers" is difficult to say, but that no one man brought these tools to their present state of perfection, is beyond doubt.

In order to explain clearly what these machines are, reference will be made to Fig. 8, which shows the general plan of some machines now under construction; the proportions are not exact, but are simply drawn to make the explanation clear. The idea is to arrange three spindles carrying taps so that they work together. In the fittings used in America a desire to economise in material has caused the bends to be made very short, thus bringing the thread ways very close together, which is an element of danger in attempting to run several taps into a fitting at the same time, as if they were made to enter but a thread too far, they would interfere and cause trouble. In order to have this danger reduced to a minimum, a stop motion was, even in the earlier days, placed on the machines, the original machines being made with one vertical and two horizontal spindles. The first idea as to holding the fitting was simply a stout, rigid vice in proper position fitted with cast-iron jaws, so made that the fitting was embedded, so to speak, in them. The operator sets the machine, puts the fitting in place, starts it, and by placing his foot on a treadle, which, through a system of levers, brings the taps up to their work and feeds them in, the stop shuts the machine off, and, on being reversed, the taps naturally screw themselves out; that is if it so happened that a thread had been made by their entering, or that if made they were not stripped when the reverse motion was thrown on. In short

the first attempt at three-way tapping was not a commercial success. Little by little the cause of failures was discovered. First it was found that the vice, instead of being a rigid affair, must have play, to a certain extent, as did the swing chuck on the drill press. This was overcome by having the chuck hinged like Fig. 9; it will be seen that the fitting in this vice will have quite an amount of up-and-down play, and by a loose fit on the bar a right and left motion is allowed; which does not require to be more than $\frac{1}{16}$ in. at the fitting. The hinge system has another advantage, as it allows the fitting to be swung, or folded back, so that it is in a convenient position to take out, and when folded back it may be slid to one side on the bar out of the way, and the second chuck, shown in Fig. 8 at Z, moved into place, and the machine started, so little time is lost while taking out and replacing a fitting.

Fig. 9.

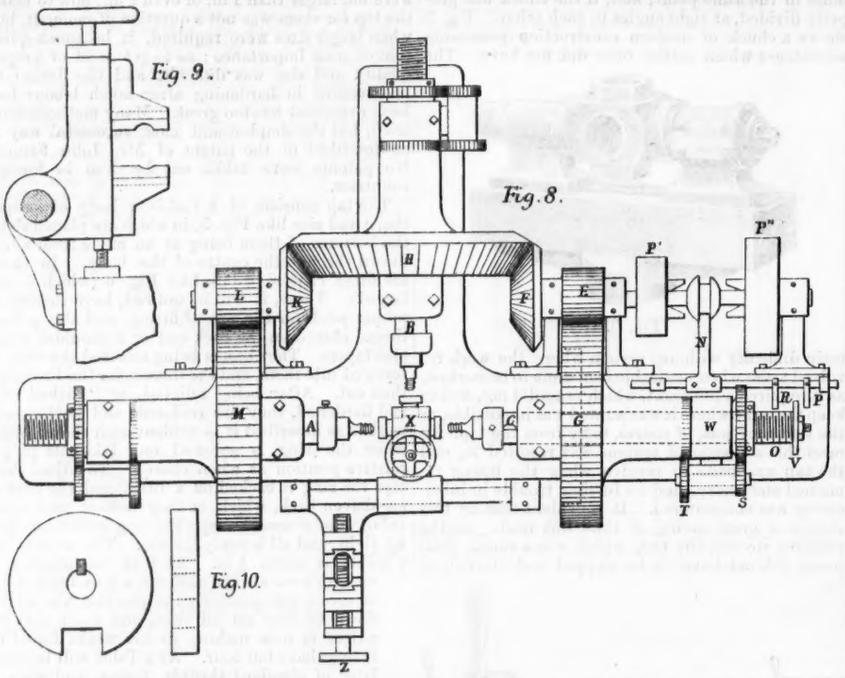


Fig. 8.

Fig. 10.

As this change did not prevent, at all times, the stripping of threads, lead screws were substituted for the levers, which helped to overcome the difficulty, but did not do so entirely, and the question of commercial advantage was not absolutely admitted. The third change has, however, put the question beyond all dispute, and it was this.

As the stripping seemed to occur at the moment of reversing, it was proposed to start the taps differentially—that is, one to be allowed to make a part of a turn before the second started, and then the third spindle to reverse. This was tried, and solved the trouble of stripping, besides lessening the strain on the entire machine.

Like the majority of tools, the power required to run a three-way tapper has never been well tested, and all the information that can be given is the belt velocity, width and size of pulleys. The distance between the pulleys is in all cases good—not less than 8 ft. The Table below gives all this information, but it must be borne in mind that two belts of sizes given are quite general on medium machines, and are always found on large sizes:

in.		in.				in.		
¼ to ⅜	machine	3	belts	650 ft.	per minute	8	pulleys	
1 ,, 2	,,	4	,,	650	,, ,,	10	,,	two belts
2½ ,, 4	,,	5	,,	750	,, ,,	12	,,	,,
4 ,, 8	,,	6	,,	800	,, ,,	14	,,	,,
8 ,, 12	,,	8	,,	800	,, ,,	18	,,	,,

The pre-requisites then for a first-class three-way tapping machine are as follows:

1. Ample power to drive it.
2. Unusual strength to meet possible strains for hard castings, &c.
3. Ease of access to all parts.
4. Independent adjustment for each tap.
5. Self-adjusting and centering vice.
6. Differential start of taps.
7. Positive stopping and reversing design.

A general idea can be obtained of the latest designs of this class of tool from the following description and drawings, Fig. 8, which supposes the observer to be looking down on the tool. The machine is shown with taps ready to start work on the in-feed; a tee is in the jaws of the chuck X folded into position, while a second chuck Z is slid to the left and thrown back, with jaws upward ready to receive a fitting. The power to drive the machine is taken from an overhead countershaft which is belted to the main line by cone pulleys in order that proper speeds may be obtained on the various sizes to be tapped; this countershaft need never be stopped, except to shift the belts. From it run belts to the two friction pulleys P^1 P^{11} shown at the back and right of the machine, the larger one driving in and the smaller for greater reversing speed. The shaft driven by these pulleys has mounted upon it spur and bevel pinions E and F, E transmitting power to the spur gear G, and F to the bevel gear H, which in turn through the bevel and spur pinions K and L transmits power to the spur gear M. On large machines a second pair of pulleys are used in the same relative position only on the left. In dotted lines through the spur gear G is shown a steel spindle C which carries a tap. A spline or keyway is made in it for about one-third its entire length. On this spindle is fitted a cast-iron disc as shown by dotted lines at G; a key in this disc fits into the spline of the spindle, preventing it from turning, but yet permitting a sliding movement of the spindle through it. Fig. 10 gives a detail view of the disc, which, it will be noticed, has a segment cut from it. In the other two discs fitted to the gears M and H, this segment is of different widths, none of the three being the same. Into these spaces project from the gears M, H, and G lugs, which it is evident, when the machine is started, must come in contact with one side of the segmental spaces, and they being of different widths start the spindles at different moments, and when reversed act in the same way against the opposite sides. The spindle C carries the spur gear G which has a cylindrical extension or sleeve on the end of which is cut gear teeth for a purpose to be explained later.

The out-board end of the spindle C is shown threaded, as are the others A and B, but on the extreme end of C is a disc which, of course, travels forward and back as the machine feeds in and out, the use of which will soon be apparent.

The gear teeth cut on the sleeve of the spur gear G work into the gear T which is mounted on a shaft, on the other end of which is the gear S. The bracket which carries this shaft is adjustable so as to permit change gears to be substituted for T and S. The gear S runs into the gear W which is threaded to meet the screw on the spindle, thereby forming a nut, and it is prevented from any lateral movement by the bearings on each side of it.

It is evident then that if properly proportioned gears are put in place of T and S, any desired feed for the spindles can be obtained, but as the number of threads to the inch as shown by the Table (given later) is eight on all sizes above 2 in. on large machines, this pitch could be cut on the spindle; but it is preferable, for the sake of wear, to make it coarser and give the proper advance by means of gear.

On a rod held by two bearings bolted to the main frame are two fingers or triggers R and P, and the clutch shifter N; to this rod is attached a weight so as to have a tendency to draw it towards the centre of the machine, or from right to left. The trigger R has a slight tipping movement enough to allow a steel toe on its short end to engage with a piece, which is movable in a slot in the main frame, being made fast at any desired point by a set screw. The finger R is simply a piece of steel which can be slid along the bar and made fast where desired. To start the machine the rod is drawn back by means of a proper lever until the thimble between the pulleys P^1 P^{11} is made to lock the larger one, and at the same time raises the weight; and the engaging of the toe on trigger R prevents the weight from drawing it out.

As the spindles feed in, the disc V on C is gradually moved towards the trigger R, and at last comes in contact with it, releasing the weight which immediately throws the rod to the left unlocking the pulley P^{11} and locking P^1, reversing the machine, and running the spindles back until the finger P is engaged by the disc V which finally lifts the weight and rod, unlocking the pulley P^1 and the machine comes to rest. During the tapping a stream of oil is thrown with considerable force into each hole, and it has been found that good oil is by far the most economical, as it allows a greater speed and effects saving in power and wear on taps. The output on first-class tapping machines, is on the average, about as follows, calling nine hours of actual running a day's work. Ten hours is a day's work, but time must be allowed to grind taps, try gauges, and adjust the machines.

in.	in.					
¼ to ⅜	machines worked in pairs	700 to 850	each, or	1400 to 1700		
2 ,, 4	,, ,,	120 ,, 400	,,	1000 ,, 1300		
4 ,, 6	,, ,,	80 ,, 120	,,	160 ,, 240		
6 ,, 8	,, ,,	60 ,, 80	,,	120 ,, 160		
10 ,, 12	,, ,,	25 ,, 40	,,	50 ,, 80		

The 12 in. machines and longer have not as yet always been used in pairs, and if used singly the man who tends it has ample time to lock after a pair of 8 in. machines if they are provided with proper lifting tackle.

The feed gears T and S do not have to be changed on what are known as standard fittings on any of the machines except the smallest, the reason for this being that all sizes of pipe above 2 in., as we have said before, have eight threads to the inch. On the smaller fittings the change of thread will be shown in the following Table:

Wrought-Iron Pipe Measurement.

Size of Pipe.	Size of Hole for Tapping.	Outside of Thread.	Length of Thread.	Number of Threads.
⅛	⅜	⅝	¾	27
¼	½	¾	¾	18
⅜	⅝	⅞	¾	18
½	¾	1	⅞	14
¾	1	1 1/16	⅞	14
1	1 5/16	1 5/16	1	11½
1¼	1 11/16	1⅝	1	11½
1½	1 15/16	1 15/16	1	11½
2	2 3/16	2⅜	1	11½
2½	2⅝	2½	1	8
3	3⅛	3 1/16	1	8
3½	3⅝	4 1/16	1 1/16	8
4	4⅛	4 1/16	1⅛	8
4½	4⅝	5 1/16	1⅛	8
5	5 1/16	5⅝	1⅛	8
6	6 1/16	6⅝	1⅛	8
7	7⅛	7 1/16	1⅛	8
8	8⅛	8 1/16	1⅛	8
10	10 1/16	10 1/16	1⅛	8

Taper ¾ in. to 1 ft., or ⅜ in. on a side.

The early fittings had the English standard of threads and sizes, but a change was made, and the measurements in the foregoing Table were, until within a few months, looked upon as the United States standard. A new system was adopted, however, on October 27, 1886, by the wrought-iron tube manufacturers, and it is known as the "Briggs Standard." It is shown in Fig. 11, and is explained by Mr. Briggs as follows:

"A longitudinal section of the tapering tube end, with the screw thread as actually formed, is shown double full size in Fig. 11 for a nominal 2½ in. tube, that is, a tube about 2½ in. internal diameter and

2⅞ in. actual external diameter. The thread for pipes employed has an angle of 60 deg.; it is slightly rounded off both at the top and at the bottom, so that the height or depth of the thread, instead of being exactly equal to the pitch, is only

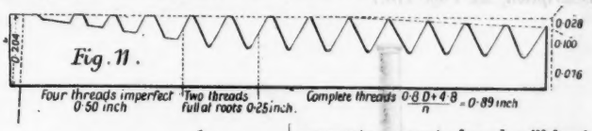


Fig. 11.

four-fifths of the pitch, or equal to $0.8 \times \frac{1}{n}$, if n be the number of threads per inch. For the length of tube end throughout which the screw thread continues perfect, the empirical formula used is $(0.8\,D + 4.8) \times \frac{1}{n}$, where D is the actual external diameter of the tube throughout its parallel length, and is expressed in inches. Further back, beyond the perfect threads, come two having the same taper at the bottom, but imperfect at the top. The remaining imperfect portion of the screw thread, furthest back from the extremity of the tube, is not essential in any way to this system of joint; and its imperfection is simply incidental to the process of cutting the thread at a single operation. From the foregoing it follows that, at the very extremity of the tube, the diameter at the bottom of the thread $= D - \left[2 \times \frac{(0.8\,D + 4.8)}{32\,n} + \frac{2 \times 0.8}{n}\right] = D - (0.05\,D + 1.9) \times \frac{1}{n}$. The thickness of iron below the bottom of the thread, at the tube extremity, is empirically taken to be $= 0.0175\,D + 0.025$. Hence the actual internal diameter d of any tube is found to be in inches

$$d = D - (0.05\,D + 1.9) \times \frac{1}{n} - 2 \times (0.0175\,D + 0.025),$$

or

$$d = 0.965\,D - 0.05\,\frac{D}{n} - \frac{1.9}{n} - 0.05."$$

For the various sizes of tubes, ranging from ⅛ in. to 10 in. nominal internal diameter, with their corresponding number of screw threads per inch, the actual internal diameter d is expressed by the following Table in terms of the actual external diameter D.

Diameters of Wrought-Iron Tubes.

Nominal External Diameter of Tube.	Number of Screw-Threads per Inch.	Actual Internal Diameter d in Terms of Actual External Diameter D.
in.	No.	in.
⅛	27	$d = 0.9631$. D − 0.1204
¼ and ⅜	18	$d = 0.9622$. D − 0.1556
½ ,, ¾	14	$d = 0.9614$. D − 0.1857
1, 1¼, 1½, and 2	11½	$d = 0.9607$. D − 0.2152
2½ to 10	8	$d = 0.9587$. D − 0.2875

To have a generally admitted standard, such as described, is of the very greatest value, but the fact of there being one does not by any means prove that manufacturers of fittings and tubes will keep any closer to it than to the old. Its beauty will shine out when they really comprehend what standard means, which to-day they do not seem able to grasp. The discovery of oil created a demand for what is known as "casing pipe," which is measured like boiler tubes, on its outside diameter. It is very thin, and a fine thread of 11 and 14, according to size, is used. On tapping fittings for it, no trouble is found, only that oil must be used a little more freely in order to wash away the small light chips which are likely to cling to and clog the taps, but in screwing the casing pipe it gives much trouble, as the thinness does not allow it to be very tightly gripped, or it would crush, and it is apt to slip, &c.

The transportation of crude oil by means of pipe lines introduced a new thread on large fittings. Why this was done is not well known, as the change was but one thread, making it nine instead of eight to the inch. The general impression is that it was done to enable the joints to be made tighter, though, again, many people think it was to prevent the stealing of fittings, which were often sent to various places in the fields and woods and left unguarded. In this description of tapping machines no mention has been made of the many abnormal designs which have from time to time been put before the public, and from which enormous outputs were to come, but only a brief notice of those machines which to-day are paying their owners handsome dividends. That more rapid moving machines will ever be made is doubtful, but it must not be thought that a state of perfection exists in these here described. Advance will be made, but it now appears to those best qualified to judge that it will be in the direction of a number of tools tended by one man, whose aggregate amount of work will be far greater than is now possible, though the work of each individual machine may be less than at present, or, at least, not more.

THE NATURAL HISTORY OF LOCAL BOARDS.

IV.—THE EXPERIMENTAL BOARD.

(*Continued from page* 150.)

IT was near Christmas when the water works were begun by the cutting of the first sod of the reservoir; an open structure, 14 ft. deep, and containing 1½ millions of gallons. Two horizontal engines were to lift the water 170 ft. into this tank. Much rejoicing took place, and the local governors specially felicitated themselves on the high name of the contractor, hoping, they said, nothing would occur to darken it. So they might, but who knows what a reservoir contract may bring forth, or what a contractor is until he has passed through trial by water? Reservoirs, until proven, are only hollow spaces; and their history is a long and woful chapter of engineering, illustrated by trials and tribulations, failure, ruin, and destruction; and also, be it said, by skill, tenacity, and resolution in the highest degree.

Before they had completed the "hollow space," we do not say reservoir, their neighbours of Drinkbilge, with a corporate elasticity of conscience, took a fancy to the site for their own big scheme, much to the indignation of the Board, who petitioned against the Bill, and without being put to the expense of a parliamentary opposition, purged it of the offending clause. The eloquence of one member compared the lawless desire with that of "David, who, with large possessions of his own, must need take Uriah's ewe lamb" (laughter). But how little do we know what is good for us? Had the Board been able to penetrate the dark future of their little "ewe lamb," they would have hailed the spoiler as their best friend. The works proceeded quickly—too quickly—both tank and mains being pushed forward; while, on the other hand, the drainage works were creeping along snail-slow. Meanwhile, new habitations sprang up like mushrooms in autumn, and in a single season a ploughed field was covered with 120 cottages, marshalled in colliers' rows; while the rural beauties of many a quiet country lane were obliterated by ill-conditioned houses and shops. Street improvements at the expense of the landowners were freely contemplated, but when asked what they would be willing to give for the land, the Board closed the question abruptly.

The Experimental Board having gone on the principle of piecemeal, it was six months after the first contract was begun, before the engineer presented his plan for the drainage of the whole district; and in another month estimates appeared swelling up to a total of 30,000*l.* for all sections of the works projected, including water, drainage, and causeways, besides the 11,000*l.* odd which the clerk reported as already expended; and the Board began to feel that they had started a vast machine whose power it seemed impossible to curb or even direct. But although the estimates swelled, the ratepaying property swelled also, and they felt the force of the saying, that he who makes much spends freely; while he who makes nothing, scruples to spend a farthing, even on repairs. They therefore asked the engineer to submit plans and estimates for a Board room and office, which accordingly he did; at the same time, candidly stating that the said plans were imaginary, because he did not know where the site was to be; in which matter it will be seen that the Board acted their experimental *rôle* with remarkable fidelity.

Dissensions arose. All their inaugurative hopes were dashed by the discovery of an alarming leak in the reservoir as soon as it was filled. Indeed, it is more than doubtful that it ever was filled; and although it was reported that the malady was cured, it broke out again and again. The Board looked askance at their cheap engineer, and matters did not mend when he presented his bill of extras. They then no longer thought him cheap, and let his bill lie on the table; a process of dealing with professional bills in which by long user they afterwards became expert. Then the medical officer sent in his first report, which was pronounced "the blackest and most doleful of reports, and what was worse, it was true." There was no use made of the new drains, he said. A dozen houses in one row had 1 in. to 12 in. of stinking water standing in their cellars. There were beastly privies with foundations sapped by water, and lying a heap of cureless and foetid ruin. And so forth, until a member grew excited and christened himself and his brethren the Old-hards Shuffling Board. "We begin it," said he; "and down it goes to the lowest official, so that from top to bottom, it ends in a regular double-shuffle;" a sentence which men of experience will agree, gives no bad idea of the decline and fall of local government. But deeper than all their misfortunes lay another source of ill-will which now characterised the relations of the Board to one another. Politics entered the sanitary arena, and old men gravely contended that the health, convenience, and decency of a district depended not so much upon a man's experience, wisdom, integrity, and force of character, as upon the all-important question whether he voted Tory or Radical. The times were beginning to halt, and commercial fever was followed by blood-letting. Radical orators knew a Tory Government had come in because trade was going out; while the Tories for the same reason, knew that a Radical Government must have been in a long time; both conclusions being equally plain to all men who could put two and two together.

Seeing the Board thus divided, landlords grew bold, and declined to supply their forlorn tenants with water and drainage until forced; while the Board by a majority of three to two decided against coercion, the last resource of wicked rulers, pinning their faith to moral suasion, being convinced that a virtuous man would rather see every law of nature outraged, the bye-laws of the Board burnt by the hangman, and the whole of his family carried off before his eyes by zymotics, than supply any want by compulsion, and so violate the sacred principle of non-coercion.

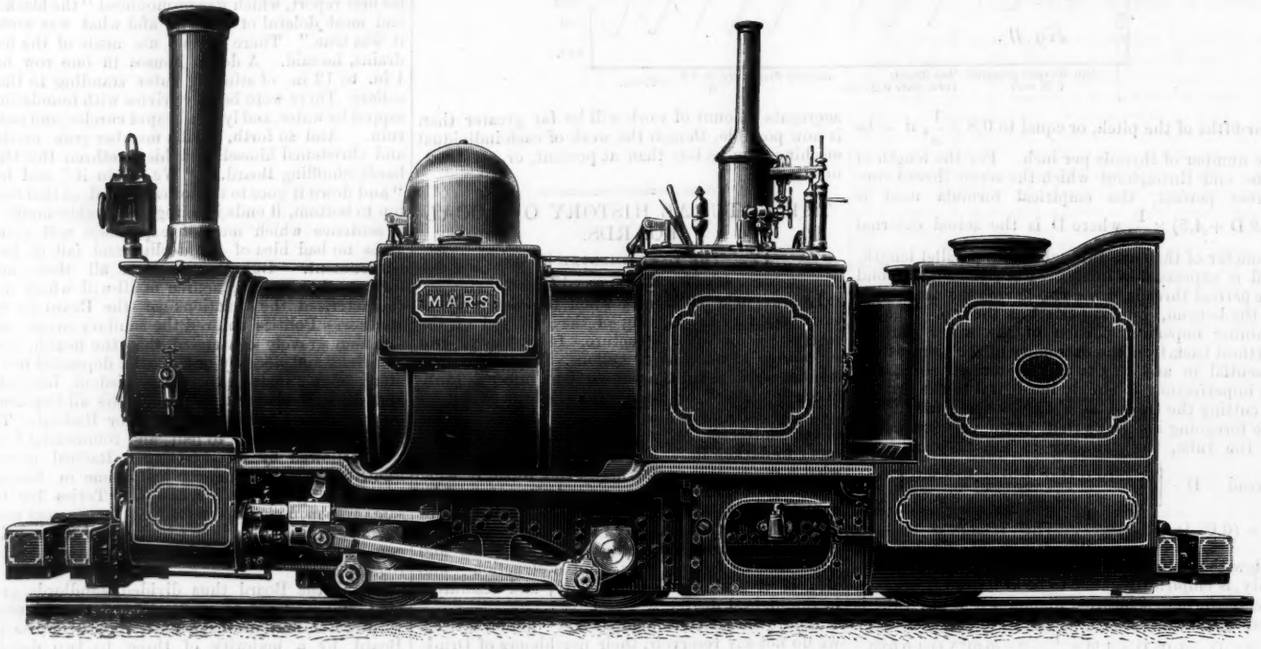
The tank proved an obstinate patient, and set all the doctoring arts of the engineers at defiance. At length, sick of repeated failures, it was decided to make a small pressure tank holding about 25,000 gallons, as a stop-gap; and in sixteen months after the commencement of works, water was turned on, much to the satisfaction of the people, who fitly inaugurated the occasion by the baptism of one of their shuffling local governors, who being got down, was played upon with a hose for some minutes. At the next election there were fifteen nominations for the three vacancies, and the trio of old members found themselves cast at the bottom of the poll. *Sic transit.* Shortly after this, an inquiry was held concerning the loan of 30,000*l.* to complete the improvements, when it was stated in evidence that the population was 8000, although six years after it was only 6000 odd. The rateable value was 33,000*l.*, having increased in five years from 9000*l.* 15,000*l.* were wanted for drainage; 5000*l.* for water; and 10,000*l.* for causeways, &c. The sewerage estimates included the purchase of 11 acres of land on which the sewage was to flow by gravitation—a sandy loam 5 ft. thick, resting on a stiff clay, and reported to be free from flood. As to water, besides the leakages, it leaked out that by some means or other the agreement with the coalowner had miscarried, and the Board, contrary to the original scheme, were to pump the water at their own cost. But nothing was done, and a second inquiry was held, owing, said the Board, to the miscalculations of their engineer. At this inquiry, and elsewhere, allegations were made questioning the results of their past labour. The levels of the main sewer were incorrect; it was laid too high, taken up and lowered 3 ft.; yet still it was 4 ft. too high for serviceable use. The water works were also the object of attack, and ridicule was poured on the specimen of an engineer's water-butt presented by the empty reservoir, the grand total of whose cost was hidden in futurity. It was also alleged that thousands of pounds had been spent for purposes not sanctioned by the department; and indeed, this could not be denied, for the application included estimates for payment of debts to that amount.

Again the Local Government Board withheld

LOCOMOTIVE FOR 18-IN. GAUGE RAILWAY AT CHATHAM.

CONSTRUCTED BY THE VULCAN FOUNDRY COMPANY, ENGINEERS, WARRINGTON.

(*For Description, see Page* 176.)

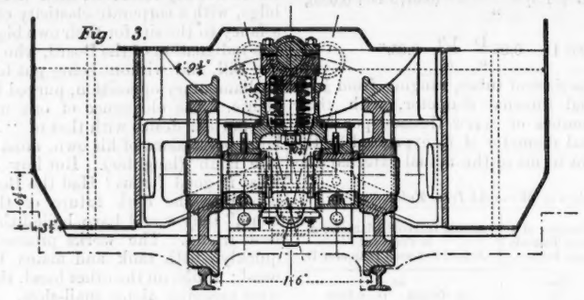


their consent. They now thoroughly distrusted the *bona fides* of the applicants, being specially aggrieved that the leakage and consequent uselessness of the tank had only been discovered by their inspector by accident, instead of being frankly stated in evidence.

The district auditor had a Herculean task before him, and he gave it up. He found the books of the Experimental Board a sealed letter, which he could by no means open; and plainly avowed that to audit them was beyond the power of man. He extracted and disallowed payments of 2500*l.* 1300*l.*, 200*l.*, severally, which had been made without contracts advertised or entered into —a direct contravention of the law. He rated the Board for going to law to save themselves the pitiful cost of a poor man's twopennyworth of bedding tainted with the small-pox and burnt; telling them they were morally and legally justified in making it good. The collector's statement he stigmatised as a farce, wrong and rotten in principle from beginning to end, calling that innocent a very simple fellow for entering upon his work without asking a syllable as to the *modus operandi*. Finally, he informed the Board that their cardinal error was in not appointing a properly qualified clerk at first, and he did not wonder that a memorial to dissolve their collective wisdom and put a Government inspector in their place, had gone up to headquarters. Schooled thus, and acknowledging their transgression, the Board promised amendment, and straightway dismissed the whole of their official staff. But their incurable infirmity broke out again, and like those who we are told on good authority go a lusting after new inventions, they were not content with the natural order of things, but begat a hybrid. They advertised for a clerk and surveyor at a salary of little more than two guineas a week, with house and gas free; and got a better specimen than they had any right to expect. They also raised the stipend of their zealous and independent medical officer, and then thought they had done great things.

The new clerk and surveyor put a new face on to business. His better qualities were soon manifested, and he showed caution, method, industry, and insight, especially into the weaknesses of mankind, and advised his bewildered employers with a clear judgment on many important matters, demeaning himself as a capable and faithful servant. A new collector was appointed, the knotted skein of accounts was unravelled with a little cutting and breaking, and the business of the district glowed

Fig. 3.



with a returning prosperity. In one serious dilemma the clerk extricated his masters with a happy address. This brings us back to the reservoir.

That forsaken monument of misconstruction had become the subject of one of those inevitable law suits which, like the troubles of man, wait upon the birth of local boards. As great nations are cradled in war, so are local boards cradled in law, without, however, becoming great. Within a year after the abortive completion of his contract, the contractor —whose name, it will be remembered, stood high at the sod-cutting—brought an assize action against the Board for the balance of over 1000*l.* still unpaid. As usual, the case was referred to arbitration, and after a host of delays and expenses, themselves the precursors of lesser suits, the matter was agreed to be settled by the payment of about three-fourths of the claim, without costs. But before the money was paid, the new clerk appeared on the scene, and it naturally occurred to him to do what it had never occurred to his masters to do before, viz., to uncover, dig into, and dissect that unlucky lining of the tank which had been so costly and so useless; by which simple means he gained so material an insight into the *status quo* that the plaintiff's solicitors were glad to cancel the signed agreement, pay the defendants' costs, and withdraw every ground of action. There the matter might have rested—a mysterious sleight-of-hand to the public—had not the plaintiff become bankrupt, when his affairs passed into other hands, and a money-lending banking company stepped into his shoes as creditors, and sued the Board for the amount agreed upon. Then in open court it was disclosed that by connivance and collusion, certain omissions of vital importance had been made in construction, and that the engineer's certificates had been fraudulently issued; and a verdict was given for the defendants with costs. An appeal was lodged in the Queen's High Court of Justice against this decision, but without success, for it was unanimously dismissed with costs by the presiding judges, who declared there was abundant evidence of fraud. Such was the sinister conclusion of the contract so auspiciously commenced seven years before.

A suit with the engineer *re* certain charges and extra charges had been a natural companion to the contractor's suit. The Board set up a counter-claim of thrice the amount, alleging negligence. An umpire was called in, who, after a delay of almost exactly nine months, announced the completion of his award, which might be taken up on payment of his fees—180*l.*—an incubation so costly that neither the Board nor their impecunious engineer would venture on the experiment of taking it up. But as time unfolded the dark doings at the reservoir, the Board's adversary showed the better part of valour; and the umpire's award to this day is known only to himself. Excessive caution and excessive charges here defeated their own purpose. Had he not opened his mouth so wide, or closed his hand so tight, he would have fared better.

To go back a little. A second engineer was brought in to prepare an estimate of the cost of making the tank tight, of whom nothing more was heard; and another inquiry for borrowing powers was held near the close of 1877, when it was set forth that, originally estimated to cost 800*l.*, the tank had already cost over 5000*l.*; and that the pumping machinery estimated at 200*l.*, had cost 2100*l.*!—the total cost of the water works being 15,000*l.*, of which nearly a third was still unpaid.

LOCOMOTIVE FOR 18-IN. GAUGE RAILWAY AT CHATHAM.

CONSTRUCTED BY THE VULCAN FOUNDRY COMPANY, ENGINEERS, WARRINGTON.

(For Description, see next Page.)

Fig. 1.

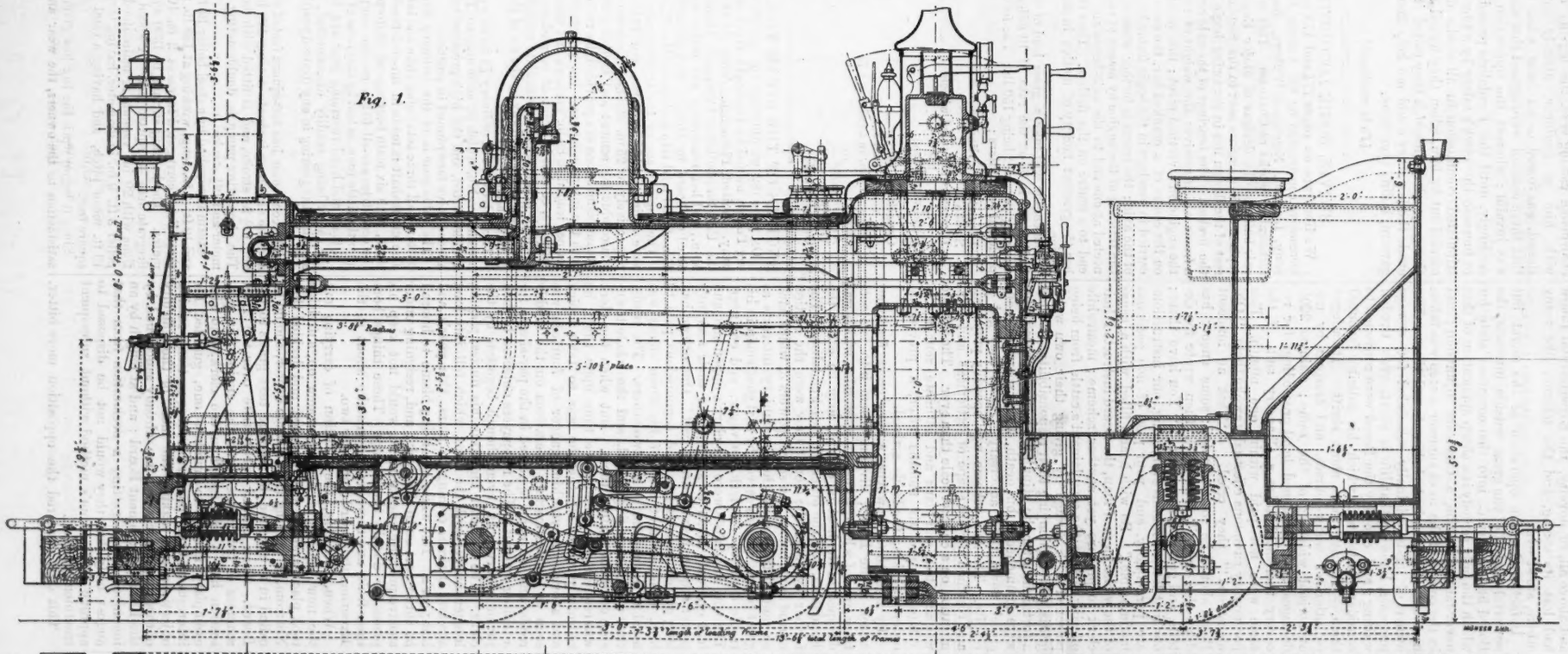
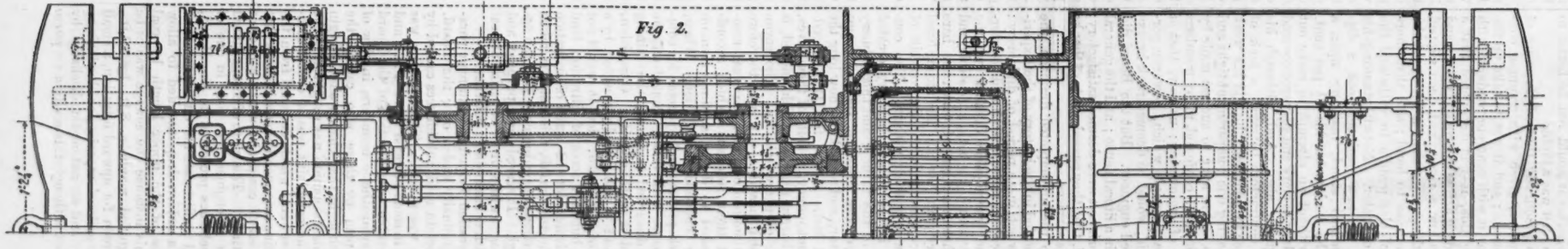


Fig. 2.



After long delays, an appeal *ad misericordiam* to the Local Government Board resulted in borrowing powers for the misspent or overspent money, 4800*l*., but for seven years only; a hard lesson in finance, which pressed heavily on the district. The leaps and bounds of the rateable value were gone, and signs of retrogression were not wanting.

Here it will be convenient to complete the history of the reservoir, and clear the way for other matters. Five thousand pounds lay buried in its sham casing, with interest going on for a generation to come. It irked the Board to look up at it; a "folly," jeering at them from the highest land in their district, and a by-word for their opponents. One member proposed to fill it, if they could, and then drown themselves in it before the water ran out and flooded the cottage cellars below. They were at the far end with the stop-gap tank; for besides the loud complaints of the coal-dust and scum suspended in the water, the constitution of this little structure was failing too, breaking up fast, it was said. The clerk (and surveyor) warily bided his time for a couple of years, gaining experience and influence. He then propounded a scheme for utilising one-third of the reservoir. Brick walls were to be cemented, and a barrier of wood and clay like a cofferdam, put across. This was to cost 130*l*., and certain works belonging to the scheme were let for 35*l*., and did not succeed. The clerk then got himself appointed engineer with a commission of 2½ per cent. on the cost of the works, and devised a scheme for dealing with the whole reser-

voir in two sections; and although there were many doubts and fears whether it would not be better to fill it up again, the plan was adopted.

The scheme was practically that of an army of engineers and witnesses, given with common consent on divers occasions; and it was to take up the bottom and re-cover it with concrete rendered with cement. In doing this, it was discovered that a great fissure extending across the rocky bottom, and big enough to swallow a river, had been slipped over, without anything more than a filling of the first rubbish which came to hand; and that there were only 6 in. of clay puddle to withstand the pressure of 14 ft. of water. Notwithstanding his dubious position, the new engineer took a dignified and determined stand, insisting upon a qualified clerk of the works; but his 2½ per cent. was not granted without an attempt to make out that his modest salary as clerk and surveyor covered the duties of engineer also. And, although his reasoning against contractors betrayed a lack of practical experience in contracts, he did his work very creditably, making one compartment tight and the other nearly so. One spur to success made by the Board would, indeed, confound many members of the noble trade of engineering; namely, that of no cure, no pay; a principle which, however permissible to a hybrid, would be deemed rank heresy by the thoroughbred engineer. But the Board did not interpret this in a literal sense; and the general results of this experiment were deemed satisfactory; so much so, indeed, that they passed a vote of thanks to the clerk for his services.

Coming now to the uncompleted drainage, the most remarkable period in the history of the Experimental Board now set in—a period of diplomacy; a period of advance and retire, march and countermarch, of talk and inexplicable dumb-show, the details of which it would be both impossible and unprofitable to chronicle; but of which the bare outline reads a very plain lesson. The strong hand of an external force became felt in the councils of the Board, and wrung their withers. The continued depression in the mining industry created profound distrust of the future; and this industry was the sole prop of the district. Its coal seams were a limited factor, and none knew how long the depression would last. It was felt that preceding boards had spent money, in spite of themselves, lavishly and with barren results; which, indeed, is the usual outcome of penny wisdom. The seven years' loan pressed heavily. It was therefore thought that the time had come for the great ratepayers to protect their interests; which accordingly they proceeded to do by sending men on to the Board who economised sanitation. When, therefore, the clerk propounded a scheme for completing the drainage, with 5000*l.* lopped off the estimates of the discarded engineer, the mining interest supported it with alacrity. Opposition, however, arose, and it was roundly asserted, by a building member of the Board, that it would not save 5000 pence; but as 4 acres of filtration land were to be substituted for 12 acres of irrigation land, besides a shorter outfall, this may be taken as one of the assertions of prejudice. But the opposition was enough. It served their purpose, and the Board, ceasing awhile from experiment, sat upon the plans with commendable patience.

Another consideration helped the drainage paralysis which had gradually stolen over the Board. The question of certain road subsidences caused by colliery workings was raised. The lowering was formidable, being in some places 3 ft. or 4 ft.; and although the charitable consideration of the Board was suggested by sympathetic members, in view of the great rates paid by those who caused the drainage, it was thought that charity should begin at home, and counsel's opinion was sought as to the responsibility. The complaint was of course communicated to the sewers, which deviated from the straight path, lapsing into such crooked courses that they became a series of cesspools, which sooner or later silted up entirely. This state of things caused a novel departure in engineering; for, in one of the innumerable schemes presented to the Board, the clerk proposed to dislocate his outfall sewer no less than 3 ft. by a sudden drop intended to allow for the subsidence of the upper length by coal workings! In this instance the sewage was to be treated in a magnified manhole, 8 ft. by 10 ft., with horizontal screen for upward filtration, a small chamber of 3000 gallons' capacity for deodorising and disinfecting, and an automatic discharge by syphon action; but although this *multum in parvo* possessed the temptations of cheapness, smallness, and above all, of novelty, the Experimental Board had lost its spring, and the scheme, like many others, stood over.

In fact, under the operation of the secret but powerful control of the great outside interests, the Board had now sunk into that comatose state for which the only remedy is a sharp application of that never-failing specific, a Chancery injunction; and in the course of the next summer a step was taken in this direction which half-wakened them. The owner of lands originally scheduled for sewage purposes, knowing that life is short, grew tired of waiting; and one day the Board were convened to consider a letter with which his solicitor favoured them. It gave them short shrift. It alleged pollution of water-courses, and trespass by unauthorised widening of the same; claimed 200*l.* damages, and threatened legal proceedings for recovery thereof, besides a Chancery suit, if the same were not paid within one month. This peremptory summons effectually awoke them. "Oh, monstrous!" they cried. "That an innocent Board should be so persecuted; some enemy has done this thing." The clerk then wrote for details, and got a curt answer. "You have them; our first letter contains everything, our instructions are peremptory, and your plea of *non possumus* inadmissible." So with hearts filled with a sense of the wickedness of man, the Board instructed their clerk to prepare yet another scheme; meanwhile offering to save the complainant's cattle from being poisoned with sewage by giving their own water gratis, yet still denying their responsibility. Within a fortnight after the stipulated notices proceedings were commenced; but death, which spares no man, struck down their adversary. Again they got a respite. The new scheme was speedily prepared, and resumed the old shape of settlement and land filtration on a cheaper scale than ever. The scheme was accepted, and plans and estimate sent up to Whitehall; and six months after, a provisional order for taking the lands arrived.

By this time, however, a very great feud had arisen in the Board, dividing them into two sections, one of which, to use an expression which was dropped in the heat of debate, may be called the Feudalists, and the other the anti-Feudalists. The former swore by the clerk; they were the section moved from below, the secret powers of which saw, or fancied they saw, their pecuniary interests as great payers of rates served by that gentleman in his treble capacity of clerk, surveyor, and engineer. The anti-Feudalists were the clerk's opponents, and had gradually risen to strength as their servant's power acquired an arbitrary cast. One or two had long girded at extra fees and commissions paid to him, thinking that each of his three offices was filled at the expense of the two others. The roads, they urged, were disgraceful, and the whole township cried out against them. But when the clerk was requested to spend more time upon them, he scornfully asked whether he was to take a pick and shovel. A youthful ganger of fourteen was seen at times directing operations on the muddy roads, and his name appeared in the pay-sheets for a trifling amount. The ratepayers objected to such juvenile surveyors, even though begotten by the clerk. The collector lagged in his duties, playing hugger-mugger with the rates, which fell into long arrears, at times coming in pairs, this year's and last year's. But while admitting blame to himself he threw part on to the clerk; and, resigning under suasive pressure, declared he would not keep his place for double the money. These things bore their fruit, and there was no mistake about it, the Experimental Board were now two.

When, therefore, the question of carrying out the new scheme of drainage came on, a division took place, and it was proposed and decided that Nostrom, a pushing little sewage doctor, should be called in to expound his sewage text gratis to the Board. Then ensued party strife over the rival schemes of treatment. But the engineer in possession had a firm friend in the clerk, who with exemplary fidelity to number one, guarded his interests at every point; blocking motions, raising objections, and making the most of the difficulty of throwing over a scheme already sanctioned by the Local Government Board; and at length by an ingenious stroke getting a declaration from that august body that they would not be disposed to approve of Nostrom's method without subsequent treatment on land.

This only rendered the opposition more bitter. A motion to dismiss the clerk having failed by the chairman's casting vote, the legality of a contract with him as engineer, already strongly questioned, was forced to an issue, when it was found that three counsel were agreed that such a contract was invalid; whereat the opposition rejoiced exceedingly, until the Feudalists passed a resolution to increase the clerk's salary by a sum equal to the stipulated commission in all works designed and carried out by him, when they waxed more furious than ever; but although they called it a dodge to evade the law, they could not help themselves, and gave in, biding their time.

(To be continued.)

SWIVEL BOGIE LOCOMOTIVE.

We illustrate on pages 174 and 175 a swivel bogie locomotive constructed by the Vulcan Foundry Company, Limited, Newton-le-Willows, for use on the fortification works at Chatham. This is the first of a pair built to the designs of Major English, R.E., to replace similar engines sent to the Soudan. The interest of the design lies in the swing bogie frame behind the firebox. The bearings of the axle are mounted on a frame which receives the weight of the rear part of the engine on a vertical pivot; this pivot is mounted on the centre of a cranked bar, the ends of which are carried in bearings in the bogie frame below the centre of the axle; the frame is further steadied and tied to the framing of the engine by means of radius bars connected at one end to the axle-boxes and at the other end to a centre on the firebox. Thus the swivel axle has the greatest facility of motion in relation to the engine.

The engine will take a gross load of 45 tons up an incline of 1 in 35 at the rate of 10 miles an hour, the working pressure being 150 lb. The following are the principal particulars;

Diameter of cylinders	7½ in.
Stroke ,, ...	12 ,,
Diameter of coupled wheels	1 ft. 8½ in.
,, bogie ,, ...	1 ,, 8½ ,,
Rigid wheel base	3 ,, 0 ,,
Total ,, ,, ...	7 ,, 6 ,,
Capacity of tank	200 gals.
,, ,, coal space	6 cwt.
Tubes; 1⅜ in. in diameter; 71	204 sq. ft.
Firebox	18.75 ,,
Area of grate...	4 ,,
Weight (loaded	10 tons
Gauge of rails	18 in.

ENGINES OF THE STEAM TUG "POWER."

On page 182 we illustrate the engines of the screw tug Power, owned by the South-West Steamship Company, Limited, Plymouth. This vessel was built by the Usk Shipbuilding Company, Limited, Newport, Mon., and her machinery and boiler were made and fitted on board by Messrs. Newall and Co., Bristol. The official trial trip took place May 27, 1886.

The engines are of the triple-expansion type, and have cylinders 15 in., 23 in., and 40 in. in diameter respectively by 25 in. stroke; they are covered with non-conducting cement and lagged with sheet iron. Steam connections are provided by reducing valves to both the intermediate and low-pressure cylinders, the former loaded to 80 lb. pressure and the latter to 30 lb. pressure, so that in event of breakdown occurring to the high-pressure or intermediate cylinders, the vessel could still make headway by the use of the low-pressure cylinder alone.

The valves are of ordinary D form, except the low-pressure valve, which is, according to Thom's patent, double-ported, and the high-pressure valve works on a loose valve face pinned in position.

The valve gear is of the ordinary Stephenson link pattern, all three sets being alike and interchangeable. The crankshaft is made in three interchangeable sections, with six main bearings of uniform length, and the eccentrics are all fitted on the couplings; consequently little room is lost by this form of valve gearing.

Steam and hand-reversing gear are both provided, the latter being readily disconnected, and used for securing the gearing in any desired position by a worm and wheel.

The condenser has 850 square feet of cooling surface, and the air-pump is single acting, 12½ in. in diameter and 12½ in. stroke, and is fitted with metallic valves. The circulating pump is double-acting, 9 in. in diameter and 12½ stroke.

Steam is supplied by a steel boiler 12 ft. in diameter and 10 ft. 3 in. long, working at 150 lb. pressure, with three Fox's corrugated furnaces 2 ft. 10 in. mean diameter. The heating surface is 1390 square feet, and firegrate area 48 square feet. A speed of 104 revolutions with 29 in. vacuum is maintained with a propeller 8 ft. 9 in. in diameter, having three loose blades 13 ft. mean pitch, and having a total surface of 28½ square feet.

Since it began work the tug has given the greatest satisfaction to the owners, the wear and tear of the

machinery being extremely small. At the end of six months the engines were thoroughly examined, and were found in capital condition, the bearings showing no signs of wear. The Power will tow a 1000-ton ship of modern design at 7½ knots an hour with a consumption of 6¾ tons of Welsh coal per hour.

LAUNCHES AND TRIAL TRIPS.

ON Wednesday, February 16, the screw steamer Aguan, recently built by Messrs. Robert Duncan and Co., Port-Glasgow, had her official trial trip on the Firth of Clyde. A vessel of 1620 tons gross register, and measuring 236 ft. by 35 ft. by 26 ft. 6 in., the Aguan has been built as the first of a new fleet of steamers intended to run between New York and the coast of Central America, from which she is to carry fruit under the flag of the Honduras and Central American Steamship Company (Limited). The engines were supplied by Messrs. Muir and Houston, Glasgow. In "running the lights" the Aguan attained the very highly satisfactory speed of 14.4 knots per hour.

On the following day, Messrs. W. B. Thompson and Co. (Limited), launched from the Caledon Shipyard, Dundee, a steel screw steamer of about 200 tons, and measuring 134 ft. 6 in. by 21 ft. by 11 ft. She was named the Jubilee, and has been built to the order of the Great Northern Steam Fishing and Carrying Company (Limited), of Hull, and to class in Lloyd's Register. The machinery, which has been constructed at the Tay Foundry, comprises a pair of compound surface-condensing engines of 60 nominal horse-power, the cylinders being, respectively, 20 in. and 40 in. in diameter, with piston stroke of 27 in. Steam will be supplied from a steel boiler at a working pressure of 95 lb. per square inch. The bottom of the main hold is arranged for carrying water ballast, so that the vessel can be readily trimmed to any draught. The fore part of the hold is divided off to form an ice-room, capable of carrying 35 tons of ice. In every respect the Jubilee may be said to represent what can be regarded as a model type of steam fisher and carrier, all the most recent experience of her builders and owners having been brought to bear on her design, construction, and equipment. She is the eighth vessel built at the Caledon Shipyard for fishing purposes.

MISCELLANEA.

AN order has been made for winding up the Electrical Navigation Company.

A Committee has been appointed to inquire into the question of the supply of defective cutlasses to the Navy.

The American Senate has passed a Bill chartering the Nicaragua Canal Company, which is to be under American control, with a privilege of raising a capital of 20 millions sterling.

The Burgundia, French steamer, has been struck amidships by the spur of the Italian man-of-war Italia, and was compelled to be run ashore at Naples to prevent her sinking.

The question of establishing an independent Board for testing all materials of war is at present under the consideration of the Commission inquiring into the Ordnance Department.

In reply to a question, Mr. Stanhope has recently stated in Parliament that no extension of the War Department Steel Works has recently been authorised, and none is in contemplation.

The steamship Great Eastern has been sold at Liverpool by auction for 26,000*l.* The purchaser, Mr. Thomas Brown, is said to be acting for the London and Australian Steamship Company.

It appears from a statement made by Lord Harris that a large number of bayonets and cutlasses recently complained of were made at Solingen, in Germany, and not in England, as previously stated.

The new provisional regulations for the navigation of the Suez Canal at night by means of the electric light have been forwarded to the Government, and were published in the *Gazette* of the 15th inst.

It is the intention of the Government to refer the Army and Navy Estimates to a Committee of the House of Commons for examination and report, in accordance with the suggestions made by Lord Randolph Churchill.

The Grant Envelope Machine Company (Limited) is a new undertaking which has been formed to acquire and develop for Great Britain, France, Belgium, Austria-Hungary, Germany, &c., all the patent rights of the "Grant rotary envelope machine," a new invention for making envelopes.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended February 13, amounted, on 15,388¾ miles, to 1,070,578*l.*, and for the corresponding period of 1886, on 15,257 miles, to 1,055,755*l.*, an increase of 131¾ miles, or 0.8 per cent., and an increase of 14,823*l.*, or 1.4 per cent.

The Umbria, one of the three Cunard steamers which the Admiralty have taken up to act as armed cruisers in case of war, is now being fitted with platforms on her turtle backs fore and aft, so that while continuing in the regular course of her trade she can be at once fitted with guns should an emergency arise.

The Cunard Line steamer Etruria, which arrived at New York early on Saturday morning, made the shortest Transatlantic voyage—six days four hours and 45 minutes—from Fastnet to Sandy Hook, with an average hourly speed of 19 knots in a total run of 2108 miles. This is three hours quicker than the previous fastest voyage, which was also by the Etruria.

The prospectus has been issued of Winfields (Limited). The capital is 160,000*l.* The company has been formed for the purpose of taking over the business of R. W. Winfield and Co., manufacturers of brass and ironwork of every description, in addition to which the firm have, in recent years, added electric lighting. Mr. Charles W. Torr will continue as managing director.

The Indian Government have not yet decided in what manner the ruby mines in Burmah shall be worked. The Government will either appoint an agent who will work the mines in their interest or lease them. The methods hitherto pursued have been of the most primitive kind, and it remains to be seen whether Western modes and mechanism will prove better adapted to the work.

Mr. Gordon Bennett's yacht, the Namouna, passed through the Suez Canal on the night of the 29th of January in 13 hours 52 minutes. It had the electric light, and being a yacht was exempt from the rule limiting the speed to six kilometres an hour. This rule makes 16 hours the minimum time for ordinary vessels, and passages of 17 hours with the electric light are now frequently made.

The Penang tramways, which have been in process of construction for the past fifteen months, were successfully opened for traffic on the 2nd inst., and the revenues they have since been yielding are far in excess of the most sanguine expectations. Messrs. Kerr, Stuart, and Co., of London and Glasgow, are the engineers and contractors for the line, which is said to be in every respect, especially as to its equipments, one of the best in India.

The Democratic party in the United States are determined not to accept any of the Bills recently passed by the Senate, voting large sums for guns, ships, and forts. The military committee of the House has prepared a Bill voting 5,000,000 dols. for the cost of new guns, and of the torpedo service, which Bill will be reported to the House. It is believed that little will be done this session to provide for the execution of defensive works.

The Royal Commission upon Ordnance Stores resumed its sittings on Tuesday, after an adjournment of three weeks, Mr. Justice Stephen, the chairman of the Commission, having during the interval been engaged upon circuit. Lord Charles Beresford, M.P., gave evidence at considerable length as to the arms and other naval and military stores that have from time to time come under his inspection, and General Boxer gave evidence as to the cartridges supplied.

As a result of the agitation which was commenced in the spring of last year by the Anglo-American Brush Electric Light Corporation for an alteration of the railway classification as regards the carriage of dynamo and other electrical machinery, it has been decided that the Clearing House classification for apparatus of this description will now be: Not packed, 3v.; in cases, 2nd. The reduction of rates effected by this alteration represents a very considerable saving in the expenditure for carriage of electrical machinery.

A *Times* correspondent states: "The Lords of the Admiralty have decided to ask for a large supplementary estimate, deficits having occurred under nearly every head of service through under-estimating the expenditure at the commencement of the financial year. Another cause of deficiency is the rapid rate at which the ship-building programme has been carried out. The Renown and Sanspareil especially have been pressed on so rapidly that additional expenditure of nearly 100,000*l.* has been incurred. Another item is 65,000*l.* for armour-plates required for these and other ships; and very large amounts not provided for have been expended in the purchase of coal and other stores by ships on foreign stations."

It is reported that the arrangements for the fitting out of the merchant vessels intended to act as auxiliary cruisers to the Navy in time of war are almost complete. The Admiralty have pressed forward the preparation of the guns and stores for at least thirty of the vessels, which are to be held at the service of the Government, and the whole of the armaments are expected to be completed by March 31, with the exception of a few spare fittings. The cruisers have been divided into three or four classes, with corresponding crews and armaments, and will be commissioned at Portsmouth, Devonport, and Chatham. The 5-in. gun is the recognised arm of the merchant fleet, and the Admiralty have decided to allot a certain proportion of quick-firing and machine guns to each ship, according to its classification in the list.

In answer to a question asked in the House of Commons the following statement has been made by Mr. E. Stanhope respecting the steel plant at Woolwich Arsenal. "In July, 1884, there were three furnaces capable of casting respectively 3 tons, 6 tons, and 13 tons, and of these the two larger could be run into one mould. But the larger furnace was found to be inconveniently situated, and in 1884 authority was obtained to remove it to another building. This furnace, when completed, will cast a 15-ton ingot, and in its place another was put in hand of about six tons power. No hopes were held out that the example of other countries in confining the manufacture of steel to the working up of material obtained from the trade would be followed; but some of the firms at Sheffield and Sir Joseph Whitworth were asked to increase their plant in view of large Government orders for gun forges. This understanding was entered into by the then Surveyor-General of Ordnance, but, unfortunately, it was not reduced to writing, and I have found no record of it in the War Office. The promises made in 1884 were partly fulfilled in 1885, when large orders were given, but I may say that I am personally satisfied that a pledge was given to the trade, and I will do my best, within the limits of the Parliamentary grants to keep it."

A new device for launching her under-water torpedoes free from the sides of the ship without the assistance of a shield and guide bar, has been tested at Portsmouth on the Mersey. Slits about 9 ft. long were cut through the skin, the interior space tapering to the impulse tube, so as to admit of the missile being deflected on feeling the pressure of the water without endangering the delicate rear mechanism. Up to a speed of 12 knots fairly good runs were made; but when the vessel was driven at a maximum speed of 18 knots nothing but misfortunes occurred. One torpedo was lost, but was subsequently picked up on the beach at Osborne, and at the next discharge a second torpedo was completely broken up. It was at first supposed that the telescoping of the Whitehead was owing to too much pressure—which was equal to a force of 6000 lb.—being applied to the rear to shoot it out of the tube. The fact, however, that the head was violently wrenched off, coupled with subsequent experience, seemed to warrant the conclusion that the fracture was due to the absence of the usual supports to the weapon until fairly away from the ship. Other experiments were afterwards prosecuted with dummy torpedoes, which, when picked up after being fired, were found to be severely scored by the friction to which they had been subjected in the act of launching. The behaviour of the torpedoes was also unsatisfactory, for instead of taking a course at right angles with the ship, they ran parallel to her, and were in danger of being destroyed by the blades of the screw. The officers in charge of the experiments have decided to condemn the new tubes, so that it is probable the Mersey will be provided with torpedo gear similar to that of the Polyphemus, which has answered well since modifications were made in the shield and bar.

The Report of the Admiralty Committee on Contracts has not yet been issued, but a daily contemporary gives the following quotations, which are stated to be taken from the report: The Committee alludes to the "many and grave defects" which it believes to exist in the general administration of the Admiralty. These defects chiefly arise from a want of co-operation between the Director of Contracts and the receivers, examiners, and users of the various articles supplied; thus a delay in furnishing specifications and patterns follows. When stores are purchased it is the business of the storekeeper to notify the fact to the principal officers of the department for purposes of examination. These principal officers have so much other work that they relegate the duty of examination to subordinates, such as foremen, on whom it cast the responsibilty of pronoucing on the quality of the goods delivered. The examination of stores should not be conducted by those into whose charge they pass when required for use. The matter of hulls and engines is so important that the Committee refers to it at length. The principle of paying a premium on each indicated horse-power developed is declared to be injurious and costly. As evidence of the unsatisfactory nature of the present system, the contracts for engines of the Renown and Sans Pareil are mentioned. In 1885 tenders were invited for engines to indicate 5500 horse-power by natural draught and 8500 by forced draught for both these ships. The offer finally accepted provided for engines of 10,000 horse-power, although two others for the precise amount of horse-power required had been received. The estimate made by the late professional officers, Sir N. Barnaby and Mr. Wright, C.B., of the value of the additional power thus supplied the Committee believes to have been purely arbitrary and fallacious, for while they placed it at 15,000*l.* for each ship, another witness of large experience placed it as low as 2000*l.*, and two other contractors offered to supply the extra power required free of cost. Novel machinery should not be allowed to be tested by the makers, persons in the service, at the public cost, and patents afterwards taken out to the prejudice of the service. More expedition is required in the passing of contractors' claims for ships and engines. Conferences between the heads of the purchasing departments of the Admiralty, War, and India Offices would be of general benefit.

A COSTLY RUSSIAN RAILWAY.—A project is on foot for a railway along the south coast of the Crimea to connect Sebastopol with Yalta. The construction of this line would be costly, as seventeen tunnels would occur upon it. The expense was at first estimated at 60,000 roubles per verst, but the estimate has since been reduced to 42,000 roubles per verst.

THE MANCE GRAPNEL.—Sir Henry Mance has devised a grapnel for lifting submarine cables, which has, in addition to the ordinary pair of prongs, a pair of curved bars which spring from the neck of the grapnel and bend over towards the toes of the prongs but do not meet these. They serve as fenders or protectors of the prongs on rocky ground, while allowing the cable to be caught on the prongs in the usual way.

GAS AT LEICESTER.—The Leicester Town Council has resolved to enlarge the Leicester Corporation Gas Works at an estimated cost of 100,000*l.* The maximum daily consumption during the present winter has exceeded the productive resources of the existing works, so that the management has been obliged to draw upon the reserved gas. It is proposed to enlarge the present works in two sections. The first section will cost 100,000*l.*, and will increase the productive power of the works about 2,000,000 cubic feet per day. If the consumption of gas in Leicester continues to increase at its present rate of progress, the second new section in contemplation will have to be carried out at a comparatively early date.

LAKE SUPERIOR COPPER MINING.

*On Copper Mining in the Lake Superior District.**

By Mr. Edgar P. Rathbone, of London.

(*Continued from page* 166.)

Stamp-Rock Mining.—The plan of working stamp-rock mines consists firstly in sinking shafts, which are usually inclined, following the dip of the vein, and are at a distance of from 500 ft. to 1000 ft. apart. They are rectangular in section, a common size being 12 ft. by 8 ft. At some of the larger mines man engines are placed in the shafts for lowering and raising the miners to and from their work. Shaft sinking is usually done by contract; the price paid in 1884 varied from 15 dols. to 30 dols. per lineal foot, equal to about 18*l.* to 36*l.* per fathom, according to the size of the shaft and character of the ground.

Levels or horizontal drifts are driven from the shafts, at distances of from 90 ft. to 100 ft. apart on the inclination of the vein, equivalent to vertical distances of say from 60 ft. to 65 ft. apart. The levels are usually from 6 ft. to 7 ft. high by 5 ft. to 6 ft. wide, and are driven by means of power drills, the work being let on contract to gangs of two or four men, according to the size of the drift: the price paid in 1884 varied from 7 dols. to 12 dols. per lineal foot, equal to about 8*l.* to 14*l.* per fathom, according to the character of the ground; the men are charged with the cost of steel, powder, candles, and supplies used by them. The advance per month varies considerably, but may be taken to average from 50 ft. to 100 ft. The shot holes are drilled from 3 ft. to 6 ft. deep and from 3 in. to 1½ in. in diameter, starting with the larger diameter and finishing with the smaller. The quantity of powder used varies much according to its quality and the character of the ground, but may be taken to range from ½ lb. to 3 lb. per hole. Two men working one drill will make about 20 ft. of drill holes in a shift of twelve hours in moderately easy ground. The drifts when completed are laid with rails weighing from 12 lb. to 15 lb. per yard. The rock is trammed along them by hand in small wagons, constructed usually of iron, but sometimes with a wooden body: they weigh from 6 cwt. to 10 cwt., and have a capacity of from 1 to 1½ tons.

On arrival at the shaft the wagon is tipped direct into the bucket or skip, the mouth of which is so shaped as to lie flush with the edge of the "tip-plat;" or, in other words, the skip while lying at the same inclination as the shaft has its mouth horizontal, as shown in Fig. 2. The skip is constructed of iron, weighing about 2 tons, and having a capacity of from 1½ to 2 tons. It is kept in position at the tip-plat by a bar of wood placed beneath it transversely across the shaft, and fitted with levers, whereby it can be quickly removed, so as to leave the shaft clear for the skip to travel freely past the level. A common size for a skip is 6 ft. long, 3 ft. high, and 3½ ft. wide. It is fitted with four wheels of 14 in. diameter, and set 3 ft. apart, with a gauge of 3 ft. 8 in. to 4 ft.; the upper or front pair of wheels have a 3-in. tread, and the lower or hind pair, which are set as far back as possible, have a 6-in. tread. The broader tread of the hind wheels is for the purpose of tipping the skip automatically on its arrival at the top of the shaft, which is effected in the following simple and ingenious manner, as illustrated in Fig. 3. At the place where it is desired to tip, the inner part of the inclined skip-road, which is laid with rails weighing 25 lb. per yard, is turned off horizontally, and along this narrower part the front wheels run, whilst the hind wheels, on account of their broader tread, are caught up by the outer and wider part of the road, which continues to run upwards at its original inclination. In this way the skip is tipped forwards or inverted, swinging on its hind wheels, while to its centre is attached the bale whereby it is connected with the winding rope.

The rock is not unfrequently hoisted from one level to another through the intermediate blind shafts or winzes, in a bucket or small skip wound by a winch, which is sometimes driven by compressed air. Small compressed air winches have been introduced only of late years, but have proved a very useful adjunct in large mines where air-compressing machinery is employed. They are self-contained, and are fixed on a bedplate 5 ft. to 6 ft. long and 2 ft. to 3 ft. wide, and can easily be removed on a trolly from place to place; they have a single cylinder 6 in. to 8 in. in diameter, with slot-link reversing motion, and drive the winding drum through spur gearing; the depth being small, no brake is required. It is estimated that each consumes about three times as much air as one drill. The branch from the main air pipe is simply attached to the winch with a tap.

As soon as the levels have been driven forwards to a sufficient distance from the shafts or winzes, the ground standing between the levels is extracted by overhand stoping, the miners breaking down the rock from the roof or back of the level, and thus working upwards from each lower level towards the one above. This work also is done with power drills. The stoping is started at from 10 ft. to 14 ft. distance from the shaft or winze, so as to leave a shaft pillar of that thickness on each side; and it is not carried up higher than from 6 ft. to 10 ft. below the bottom of the next level above, so as to leave a floor of that thickness for the upper level. In this way the stopes are worked out along the whole length of each level in a series of inverted steps like the underside of a staircase, proceeding in successively rising stages. Each fathom in length is assumed to be one square fathom in cross section, and is known to miners as a "running fathom" of ground.

Timbermen follow on after the miners, and timber up the stopes with rows of large cross-timbers or props fixed close together, so as to support the hanging wall or upper side of the cavity from the foot-wall or under side. In the Calumet and Hecla mines the upright or sloping timbers, which are placed parallel with the shafts, are set from 4 ft. to 6 ft. apart, instead of close together side by side, and are framed into sills at bottom and caps at top; in this way considerable economy is effected, inasmuch as squared timber of 12 in. to 14 in. scantling can be used for the side posts, instead of round timber 2 ft. to 3 ft. in diameter; there is also a saving in time and labour through the diminished handling of the timber, special wood-cutting machinery being employed to cut out the necessary joints. The timbering forms one of the heaviest items of cost in the Lake Superior mines, amounting frequently to as much as 10 per cent. of the entire mining cost.

At the Calumet and Hecla mines the mode of contracting for stoping is peculiar; the men are paid from 11 dols. to 13 dols. (46s. to 54s.) per cubic fathom, the vein being taken to average 2 fathoms, or 12 ft. in width; should it widen to 14 ft., the extra 2 ft. are not allowed for in the contract price; on the other hand, the men derive an equivalent advantage when the vein narrows up to 10 ft. A running fathom of 216 cubic feet is equivalent to 18 or 19 tons of rock. Blasting is usually done between shifts, namely, between six and 7 o'clock in the evening; at some mines it is carried out by a special gang of men, and not by the miners.

Winding Engines.—The winding engines are frequently situated at some distance from the shafts, and one engine winds from several different shafts; the rope, which is of steel wire, is carried over a series of sheaves. The engines are not unfrequently fitted with **V** friction gearing, in place of the ordinary spur gearing; and are always supplied with a powerful steam brake. The most remarkable winding engine in the district, and probably in the world, is that lately erected at the Calumet and Hecla mines; it is a compound condensing and rotary beam engine designed by Mr. E. D. Leavitt, Jun., having a 40-in. high-pressure cylinder working with 135 lb. steam, and a 70-in. low-pressure cylinder, with 6 ft. stroke. At 36 revolutions per minute, it is stated to develop 2500 indicated horse-power, and to be capable of increasing to 4100 horse-power at 60 revolutions. The flywheels are 32 ft. in diameter, and weigh 45 tons each. The main shaft on which they are mounted is 18 in. maximum diameter, and 14 in minimum, and 130 ft. long. It is coupled to three pairs of air compressors, one with 36-in. cylinders and 5 ft. stroke, and two with 32-in. cylinders and 4 ft. stroke; and also to six winding drums 20 ft. in diameter, which are fitted with hydraulic clutch gearing. Each drum weighs about 60 tons, and is capable of coiling 4000 ft. of 1¼-in. steel wire rope at a speed of 1000 ft. per minute.

Rock Houses.—As a rule very little selection of the stone

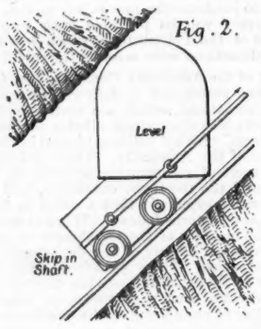


Fig. 2.

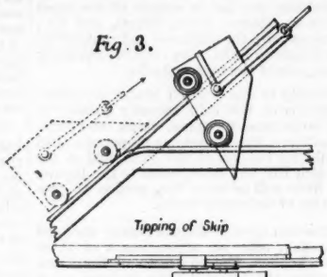


Fig. 3.

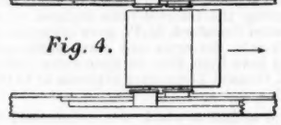


Fig. 4.

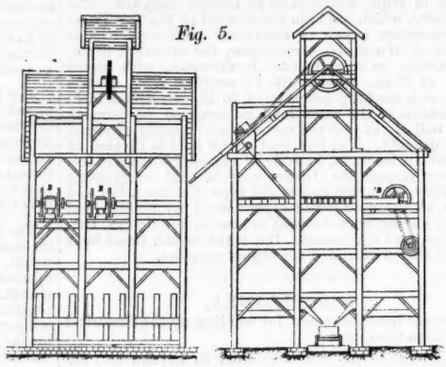


Fig. 5.

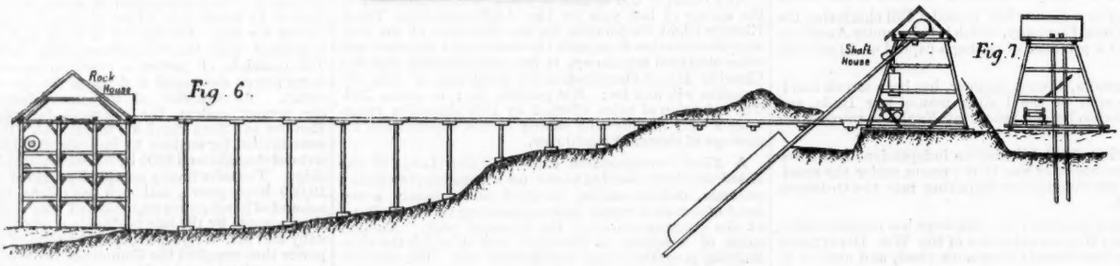


Fig. 6.

Fig. 7.

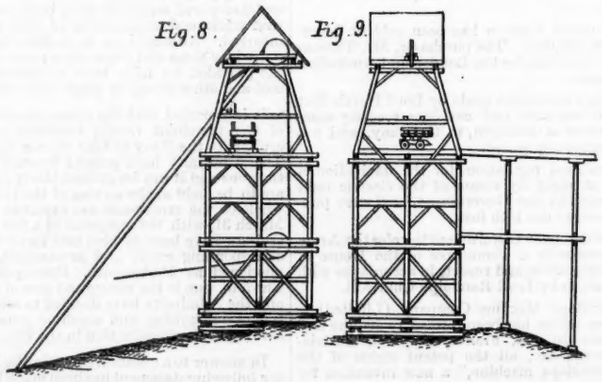


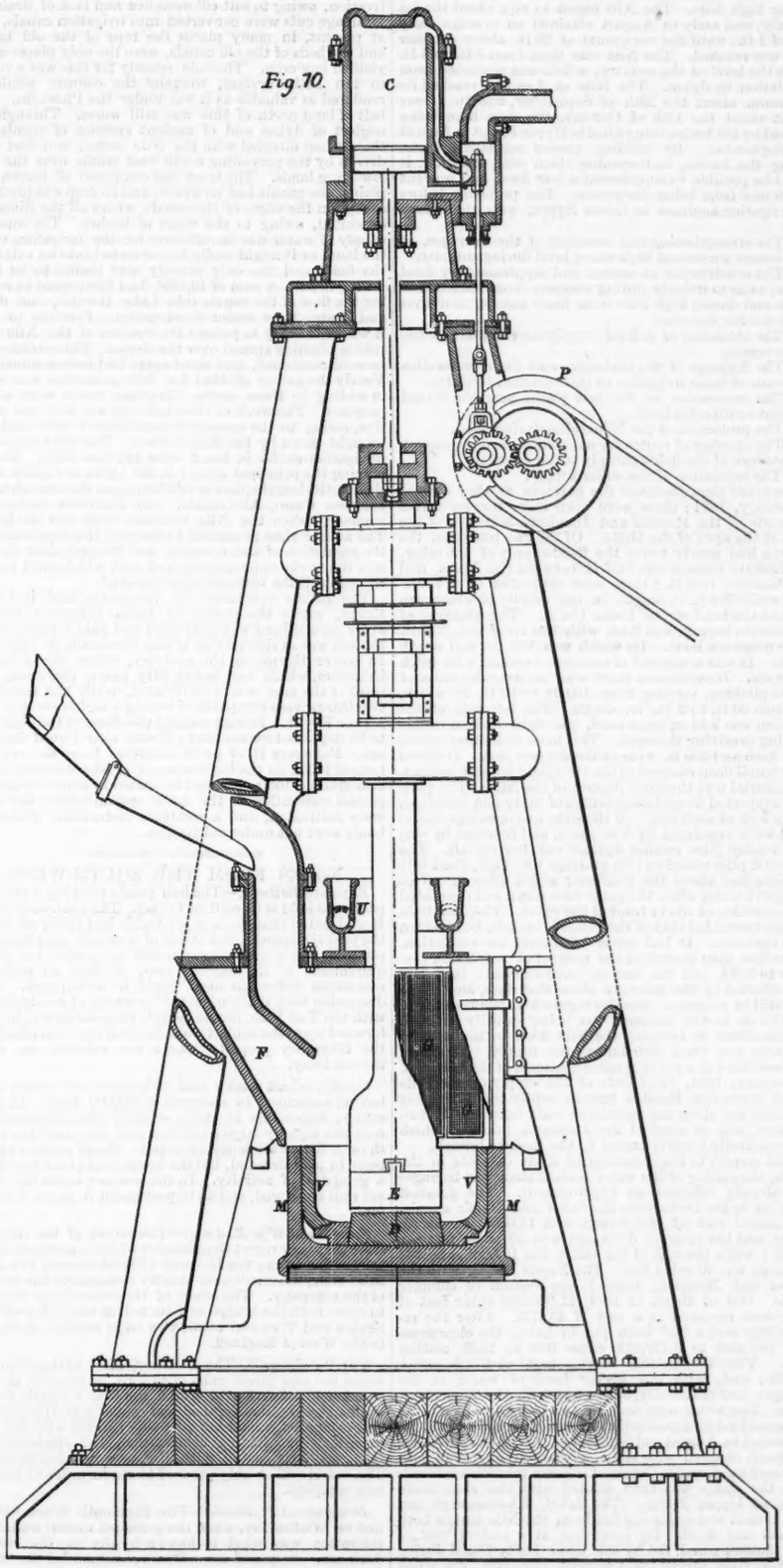
Fig. 8.

Fig. 9.

* Paper read before the Institution of Mechanical Engineers.

THE BALL STEAM STAMP.

Fig 10.



is made in the mine, since it is found not practicable to carry out underground an economical separation of the dead or barren country rock from the copper-bearing vein-stone. The whole of the mine stuff is consequently drawn to the surface, and taken direct into the rock house, which, wherever practicable, is situated in a direct line with the inclined shaft, as shown in Figs. 4 and 5, and close up to its mouth, so that the skip tips directly into it. Generally, however, the rock house receives the stuff from several shafts situated some distance apart; and at the mouth of each, as shown in Figs. 6 and 7, the skip tips into a wagon, which is run and tipped into the rock house by an endless wire rope. The stuff thus tipped passes over a sloping screen or griddle (Fig. 5) of wooden bars from 2in. to 3in. apart; the pieces passing through are small enough to treat at once in the stamp mill. The larger lumps requiring to be reduced in size are broken by Blake crushers B (Fig. 5), the jaws of which are usually 16 in. by 24 in. or 10 in. by 15 in. The larger size will break from 300 to 350 tons of rock per day when of a soft amygdaloidal character; but of conglomerate rock it would break only about half as much. A more or less perfect separation of the stuff is effected in the rock house by breaking up with sledge hammers the pieces too large for the crusher; the poor rock is thrown out into tram wagons, from which it is tipped on the burrow or waste heap. Pieces of nearly pure copper, too large for the stamp mill, are cleaned up by hand with hammers and chisels to about 65 per cent. of pure copper, and are packed into barrels and sent direct to the smelting works.

Stamp Mills.—Owing to the need of a large supply of water, the stamp mills are generally situated on the banks of Lake Superior, and consequently at some distance from the mines, from which the stuff is brought by railway. The trucks transporting it are fitted with drop bottoms, and have a capacity of from three to four tons. They are run directly over a series of hoppers or shoots, Fig. 8, situated immediately behind the mill, into which the rock is discharged by opening the bottom of the truck. Thence it passes down an inclined shoot into the mortar of the stamp, the feed being regulated by hand.

The "Ball" stamp, so named because invented by William Ball in 1856, is the one that is in almost universal use throughout the district; it is shown in Fig. 10. Being constructed very much on the principle of a steam hammer, it requires very solid foundations. A pit is dug 12 ft. to 14 ft. deep, and 26 ft. to 30 ft. square, which is lined with a stone walling 4½ ft. thick at the bottom, and 3 ft. thick at the top. The bottom of the pit receives a concrete floor from 12 in. to 14 in. thick, upon which are laid timbers 14 in. square and 19 ft. long, leaving spaces of 2 in. to 3 in. between them, and 9 in. to 18 in. at the sides of the pit. The spaces are filled in with small broken rock and floated with cement, a layer being thus laid during the day and allowed to set during the night. A dozen layers are so built up, the timbers being laid in alternate directions across the pit; there are thus about 168 timbers in all. On the top layers are fixed, one on each side of the woodwork, two longitudinal cast-iron sills or girders, strengthened by knee braces, and secured by about fifty iron holding-down bolts or tie rods of 2½ in. round iron, which pass down between the alternating timbers to the bottom, where they are fastened to a heavy baseplate. Laid across and bearing on the two longitudinal sills are seven spring timbers, having each a section of 16 in. by 14 in., which are held in position by two transverse cast-iron sills; these cross sills are laid outside and alongside the spring timbers, and have their ends bolted to the ends of the two longitudinal sills. The spring timbers last only from three to six months, and have then to be taken out and replaced by new ones. On the cross sills four cast-iron head-posts, inclining towards one another at the top, are framed together by cross-pieces; and to the frame so made are fixed the steam cylinder C at top, the mortar M at bottom, and the other parts of the stamp.

The mortar M is made of cast iron, and stands on a cast-iron bedplate about 20 in. thick, which is placed on the top of the spring timbers: it has thus a slight vertical movement at each blow, whereby the wear and tear of the stamp are diminished. The mortar is a circular pan, about 4½ ft. in diameter outside, and 2½ ft. high, the bottom being about 7 in. thick, and the sides 4 in. In the centre of the mortar is placed the "die" D, on which the ore is stamped; it is a conical cast-iron block about 7 in. high, tapering from about 22 in. diameter at the bottom to 20 in. at the top. Upon it fits a cast-iron ring, about 5 in. thick and 6 in. broad, having an outside conical flange for supporting the bottoms of the "stave liners" V, which line the inside circumference of the mortar and keep the die central within it. The stave liners are cast-iron plates about 18 in. high and 2½ in. thick, curved so as to fit the inside of the mortar, around which they are carefully wedged up tight, leaving a clear internal diameter inside them of about 3½ ft. The die, ring, and stave liners last about eighteen months, and have then to be taken out and renewed.

The frame F of the mortar is about 4 ft. square at the base, and 3½ ft. high, and is inclined so as to project outwards at top about 2 ft. from the perpendicular. In the frame are fixed four screens sliding into grooves, each containing four grates G of sheet steel about 3½ ft. high and 7½ in. broad, which are punched with holes $\frac{1}{16}$ in. in diameter and ½ in. apart horizontally, and ½ in. vertically. At some of the mills oblong holes, ½ in. by $\frac{1}{16}$ in., have been substituted for the $\frac{1}{16}$ in. round holes, to facilitate the passage of flat and oblong pieces of copper. The screens are shielded outside by heavy iron splashboards, which are held in position by an iron crossbar bolted on to the mortar frame. At the bottom and outside each screen there is a discharge pipe 3 in. or 4 in. in diameter, through which the stream of copper sands passes into a series of launders connected with the jigs or washers. On the top of the mortar is fixed the "urn" U, a circular cast-iron cistern into which water is led by a 4-in. pipe to supply the mortar. Alongside is fixed a cast-iron feed hopper, with a mouth about 16 in. by 14 in., through which the rock passes from the shoots into the mortar, where it is then crushed in a large volume of water, each ton of rock crushed requiring from 25 to 30 tons of water.

The stamp shoe E is made with straight sides and rounded ends, about 22 in. long, 14 in. wide, and 10 in. thick; and is secured by a dovetail joint on the bottom of the vertical shaft or stamp bar, which is 10 in. in diameter and weighs nearly 2000 lb. The shoe weighs about 630 lb., and lasts from one to three weeks according to the material of which it is made, and the character of the rock stamped. The best mixture for the shoe is chilled white and grey iron with a certain amount of Franklin spiegel. The time occupied in changing a shoe is about one hour.

The stamp is worked by a vertical steam cylinder C,

which varies in diameter in different mills from 15 in. to 19 in., and is fixed centrally on the top of the stamp frame. Near the top of the head posts is fixed a pulley P, 20 in. in diameter, driven by the horizontal mill engine, which also works all the other machinery in the mill through pulleys, shafts, and belting. The shaft of the pulley carries an elliptical spurwheel, which gears into a corresponding wheel, and gives motion to an eccentric on the shaft of the second elliptical wheel, whereby the slide valve of the stamp cylinder is worked in such a manner as to keep the top steam port fully open for admitting the full pressure of steam during the downstroke, whereas only about one-eighth of the lower steam port is opened for the upstroke and with a quicker motion of the valve. The piston consequently travels with much greater velocity and force during the downstroke than during the upstroke. The cylinder is made with a counter bore at the bottom, into which the piston will drop if ever the feed of rock be allowed to get too low in the mortar beneath the stamp shoe; the steam above the piston then escapes past the sides of the piston, and the stamp is immediately brought to rest, thus preventing the bottom of the cylinder from being knocked out or any other damage from being done to the stamp. The piston has a stroke of 2 ft., and the stamp gives from 90 to 100 blows per minute, with a steam pressure of from 80 lb. to 100 lb. The piston rod is connected with the stamp shaft by a circular disc or cheese-head fixed on the bottom of the rod, which is encased by an iron bonnet bolted on the top of the stamp shaft; the cheese-head is secured within the bonnet by india-rubber packing on each side. The stamp shaft works through guides fixed between the braces of the head posts; and round it is placed a revolving clamp and pulley, having feathers which work in splines or grooves cut in the stamp shaft. A belt round the pulley rotates the stamp shaft during its up and down strokes, causing the oblong shoe to strike continually in a fresh place, and thus to prevent the rock from packing in the mortar.

The net total falling weight of a Ball stamp ranges from 4000 lb. to 5000 lb., performing with the steam pressure a total work of from 100 to 180 foot-tons at each blow. The power developed in full work is from 100 to 180 indicated horse-power, and the quantity of rock crushed per twenty-four hours from 120 to 220 tons. The total weight of the stamp and frame is from 70 to 80 tons, and the cost from 1800*l.* to 2000*l.*

(*To be continued.*)

IRRIGATION IN LOWER EGYPT.

At the ordinary meeting of the Institution of Civil Engineers held on Tuesday, the 22nd of February, Mr. Edward Woods, President, in the chair, the paper read was on "Irrigation in Lower Egypt," by Mr. William Willcocks, Assoc. M. Inst. C.E.

The author observed that, owing to the absence of rain, the agriculture of Lower Egypt depended entirely on irrigation. In Upper Egypt, where the basin system of irrigation prevailed, the country along the banks of the Nile was divided by dykes into basins, varying in size from 50,000 to 8000 acres each. These basins were filled with water from the Nile in August and September, and emptied in October. Wheat, flax, or beans were then sown without ploughing, and reaped in March; and from April to July, millet, cucumbers, and melons were raised by irrigation from temporary wells. In Lower Egypt all this was changed. The year was here divided into three seasons. In the first season, or summer, from the 1st of April to the end of July, the Nile was at its lowest; the average discharge was 14,000 cubic feet per second, and the extremes were 12,000 and 25,000 cubic feet. The summer crops were cotton, rice, sugar-cane, melons, and cucumbers. The flood season lasted from August to November inclusive, when maize was chiefly grown. At this time the maximum Nile discharges varied from 187,000 cubic feet per second, in a year of low Nile, to 387,000 per second in a year of very high Nile. In the third season, December to March, the crops were wheat, beans, barley, and clover, and the discharge of the Nile varied from 25,000 to 55,000 cubic feet per second. Taking the Deltaic provinces of Menufieh and Garbieh, of which the area paying taxes was 1,170,000 acres, the results for each season, were: Summer crops, acreage 431,000, yield 3,911,000*l.*; flood crops, acreage, 590,000, yield 2,300,000*l.*; winter crops, acreage 1,002,000, yield 3,791,000*l.* To accomplish the irrigation of this area, 11,708 waterwheels, 1123 portable engines, with a joint horse-power of 9895, and 162 stationary engines, with a joint horse-power of 2395, were employed. To obviate difficulties imposed on summer irrigation by the low level of the Nile, Mehemet Ali began the barrages at the head of the Delta in 1835, and but for the *corvée*, or forced labour, he would have finished them. The *corvée* at first enabled the Government to dig the canals deep, and so dispense with the barrage; but when afterwards difficulties arose from inferior workmanship, it seemed easier to call out the *corvée* than to face the problem of the barrages. To these deep canals Egyptian irrigation owed all its troubles. Regulators had to be built at intervals of eight or ten miles along the canals, and these were closed during flood to bring the water to the surface of the land. This converted the canals into a series of pools, which formed silt traps, the Nile mud settling in the beds of the canals to the depth of 8 ft. and under, which had to be removed yearly, while the fields lost this rich mould. Moreover, owing to the excessive volume of water sent down by the canals, the country to the northward was flooded, the drains being unable to perform their proper functions; salt efflorescence was greatly on the increase in the lands under cultivation, and 300,000 acres of land in Garbieh were maintained in a state of swamp. The regulators also obstructed the canals for navigation purposes. The deep summer canals were supplemented, during flood, by a network of shallow canals, which were in operation only during high Nile. The Nile began to rise about the 1st of July, and early in August attained an average daily rate of 1 ft., until the maximum of 20 ft. above summer level was reached. The Nile was then from 3 ft. to 8 ft. above the level of the country, which was protected from inundation by dykes. The Nile at Assouan reached its maximum about the 20th of September, and in Lower Egypt about the 15th of October, the date here being delayed by the basins being filled in Upper Egypt in August and September. By building proper regulating works among the basins, and opening them with precision, it would be possible to supplement a low flood and prevent a high one from being dangerous. The problems before the irrigation engineer in Lower Egypt, were the following:

1. The strengthening and securing of the barrages, so as to insure a constant high-water level during summer.
2. The construction of escapes and supplementary flood canals, so as to irrigate during summer from the summer canals and during high Nile from flood canals, and thus prevent slime deposits.
3. The obtaining of a flood supply as early as possible in the canals.
4. The drainage of the lowlands, and their restoration by means of basin irrigation to their original fertility.
5. The conversion of the salt plains near the inland lakes into cultivable land.
6. The protection of the Nile dykes during flood.
7. The opening of routes for navigation, so as to convey the produce of the fields cheaply to the markets.
8. The regulation of the water supply.

The paper then described the barrages as they existed in January, 1884; these were open weirs thrown across the heads of the Rosetta and Damietta branches of the Nile, at the apex of the Delta. Of the two branches, the Rosetta had nearly twice the flood-supply of the other. The Rosetta barrage was 1437 ft. between the flanks, and the Damietta 1709 ft.; they were separated by a revetment wall 3280 ft. in length, in the middle of which was situated the head of the Delta Canal. The platform of the Rosetta barrage was flush with the river-bed, 29.8 ft. above mean sea level. Its width was 151 ft., and depth 11.5 ft. It was composed of concrete overlaid with brick and stone. Downstream there was an irregular talus of rubble pitching, varying from 150 ft. to 10 ft. in width, and from 50 ft. to 2 ft. in. depth. The left half of the platform was laid on loose sand, the right half on rubble pitching overlying the sand. This loose stone barrier was 30 ft. high and 200 ft. wide at the deepest part. It closed the original deep channel of the river, and its only cementing material was the slime deposit of the Nile. The platform supported a regulating bridge of sixty-one openings, with a lock at each end. Of the sixty-one openings, forty-seven were regulated by iron gates, and fourteen by vertical wooden piles resting against oak horizontals. The gates and piles rested on iron gratings 1 ft. high, fixed into the piers just above the platform, which allowed a free passage of water when the gates were down and prevented the deposition of silt in front of the gates. The Damietta barrage resembled that of the Rosetta branch, but had ten more openings. It had never been used for regulation. The author then described the method of regulation previous to 1884, and the various improvements that had been effected in the barrages since that date, and which were still in progress. Besides regulation, the training of the Nile on to the barrages was being steadily pursued. This consisted in bringing the Nile flood to the apex of the Delta and then distributing the supply. The apex had been fixed at a point 2½ miles upstream of the barrages. In January, 1884, two-thirds of the supply of the Nile passed down the Rosetta branch, while the remaining one-third ran along the revetment wall, between the two barrages, and so reached the Damietta branch, which was practically a spill-channel for the Rosetta branch.

With respect to the reduction of slime deposits in the canals, the raising of the water surface above the barrages had already effected an improvement. The greatest offenders in the Delta were the Sahel and Nagár canals. The annual cost of the former was 15,000*l.* for *corvée* labour, and the summer discharge was 80 cubic feet per second; while the cost of the latter was 18,000*l.*, and the discharge was 40 cubic feet. The Nagár Canal, with the Sabbal and Nenaiah, formed one system of summer canals. Out of these, in 1884, 31,906,388 cubic feet of slime were removed at a cost of 45,172*l.* After the remodelling works had been put in hand, the clearances were reduced to 3,727,913 cubic feet in 1886, costing 6334*l.* The remodelling works had cost altogether 15,000*l.*, and, with the higher level of water at the barrages, had practically done away with the slime clearances. The water now was always in motion, and the slime could not be deposited in the canals. A velocity of 2 ft. per second in August and September, when the Nile water was much charged with slime, prevented deposit of both slime and sand, and in October far lower velocities sufficed, since the water was then diluted with the clear basin water of Upper Egypt. The Sahel, Khadarawiah and Ataf system was originally fed from the Nile during both summer and flood. By executing, at a cost of 900*l.*, a new summer canal, fed by the main Delta Canal during summer from above the Karanaia regulator, the slime clearance had been dispensed with. The author then showed that an early flood supply could be secured in Lower Egypt by building a regulator at the head of the Bahr Shebin, a branch of the main Delta Canal; and that by utilising existing works and channels, and spending 16,000*l.*, it would be possible to nearly double the water supply of the two central provinces during the rise of the Nile, and secure an early maize crop.

The author next discussed the belt of land, 15 miles in width, which lay 65 miles north of the barrages. This was formerly very fertile. Cotton cultivation was introduced about forty years ago, and had at first answered fairly well; gradually the lower fields fell out of cultivation, owing to salt efflorescence and lack of drainage. Drainage cuts were converted into irrigation canals, and, at present, in many places the tops of the old banks, and the beds of the old canals, were the only places which yielded any crop. The sole remedy for this was a return to the basin system, whereby the country would be rendered as valuable as it was under the Pharaohs. The belt of land north of this was still worse. Through the neglect of dykes and of ancient systems of regulation, the sea had mingled with the Nile water, and had been driven by the prevailing north-west winds over the flat, low-lying lands. The tract was composed of barren salt plains, the canals had no dykes, and no crop was produced except on the edges of the canals, where all the slime was deposited, owing to the want of basins. The summer supply of water was insufficient for the irrigation of all the land, or it might easily be converted into an extensive rice field, and the only remedy was basins to be filled during flood. A sum of 10,000*l.* had been spent in reducing the flow of the canals into Lake Borillos, and dykes and drains were under construction. Previous to 1884 it was customary to protect the reaches of the Nile with rubble pitching spread over the slopes. This practice had been discontinued, and stone spurs had been commenced. Yearly the money allotted for Nile protection was spent in adding to these spurs. Training works were also in progress. The work of river training was easy and effective, owing to the enormous quantities of sand and clay brought down by the Nile in flood. The most important navigation works in hand were ten new locks. Besides making the principal canals in the Delta navigable along their entire lengths, they would keep open the through traffic between Cairo, Alexandria, and Damietta during the summer, when the Nile branches were not navigable. The author then proceeded to describe the steps taken for the regulation of water supply, and the prevalent abuses; also the works annually required, and which must be continued until the barrages were repaired.

The author concluded by remarking that in Upper Egypt, where the system of basin irrigation existed, every acre of land was cultivated and paid revenue, while the soil was as rich now as it was thousands of years ago. In Lower Egypt, on the contrary, where the system of irrigation, which had lasted fifty years, prevailed, one-third of the area was uncultivated, while the remaining two-thirds were incapable of paying a higher revenue than Upper Egypt. Nature wanted the slime of the Nile flood to be deposited on the land; it was now forced into the sea. For every 1*l.* of profit resulting from the expenditure of 1000*l.* on the improvement of the existing irrigation system, 10*l.* would be the return in money spent in a partial restoration of the basin system where the lands were cultivated, and a complete restoration where the lands were not under cultivation.

NOTES FROM THE SOUTH-WEST.

Rhymney Railway.—The half-yearly meeting of this company was held at Cardiff on Friday. The chairman (Mr. J. Bogle) stated that the iron ore traffic had fallen off during the past six months, but stores of iron ore were becoming reduced, and a large supply would be needed for the requirements of the current year, so that an increased movement under this head might be anticipated. Some discussion took place upon the necessity of amalgamation with the Taff Vale, but no definite proposition was brought forward upon the subject, and the chairman remarked that the Rhymney property was a too valuable one to be thrown away.

Cardiff.—Last week's coal shipments were again large, having amounted to upwards of 160,000 tons. It is, of course, impossible to state whether the shipments will continue equally large; but however this may be, prices show a firmer tendency all round. Small steam coal has been in poor demand, but the house coal trade has shown a good deal of activity. In the iron ore trade the works are well employed, and an improvement in prices is looked for.

Severn and Wye Railway.—The report of the directors state that they regret the necessity which compelled them to take action before the Railway Commissioners, but at the same time, the result undoubtedly strengthens the position of the company. The effect of the proceedings has been to open both the bridge and tunnel as through routes for Severn and Wye coal traffic to a large number of stations in the West of England.

The "Colossus."—The Colossus, after having taken on board her new turret guns of 45 tons, in place of the condemned 43-tonners with which she was formerly armed, has had her bottom scraped and coated with Hay's protective composition, and her port side painted with the same inventor's anti-fouling composition, her starboard side being similarly coated with Rutgen's anti-fouling paint. The vessel will shortly proceed to sea in order to test her new weapons.

Drainage at Plymouth.—The Plymouth Town Council met on Wednesday, when the principal matter under consideration was what is known locally as the western drainage. A special committee recommended the immediate erection of a pumping station, but a rider was proposed to the effect that an independent engineer should be called in to report upon the scheme for the western drainage, which had been sanctioned by the Local Government Board, and part of which was already being carried out. Upon this rider a long discussion took place, ending finally in its adoption.

The "Neptune."—The Neptune has been taking in her masts, now reduced to two, the mainmast having been previously stepped so near her funnels that two main yards

were burnt, while the men used to be scorched when going aloft. The vessel will now be schooner-rigged, and will, it is thought, be all the faster sailer for the clearing away of some of her top hamper.

Water at Newport.—A deputation of the Parliamentary Committee of the Newport Town Council, together with the town clerk (Mr. A. A. Newman), and the surveyor (Mr. C. Kirby), waited upon the directors of the Newport Water Works Company on Thursday with a view to the acquisition by the council of the company's undertaking. A sum was named by the deputation as one which they could recommend the council to pay for the water works, and, on the other hand, a price was mentioned by the directors of the company as one which they could recommend the shareholders to accept in case of sale. There was, however, so wide a divergence between the two sums that the deputation left the company's offices without any arrangement having been arrived at.

Barry Dock and Railways.—The fifth half-yearly meeting of this company was held at Cardiff on Friday, Lord Windsor presiding. The report of the engineers stated that, on contract No. 1—which included the dock works and five miles of the main railway—notwithstanding bad weather, satisfactory progress has been made with the excavation from the dock, about half the necessary quantity of soil having been removed. The masonry of the walls had been well advanced, and the dock walls commenced. A portion of the main line of railway included in this contract had been practically completed up to the cutting south of Wenvoe Tunnel. In contract No. 2 the tunnel and other heavy works were proceeding satisfactorily. The whole of the land required for contract No. 3 had been acquired and the work started, while the works on contract No. 4 were proceeding in an expeditious manner, all public road bridges, except one, having been built. Mr. Davies stated that the tunnel at Wenvoe was being finished at the rate of about 100 yards per month. A contract for supplying the dock gates at Barry has been let to the Thames Iron Works and Shipbuilding Company.

Devonport Dockyard.—It is expected that men will be shortly set to work upon the Landrail, so that she may be completed for commission March 15. The dockyard authorities are already preparing for sea the gun vessels Flamingo and Griffon, and the sloops Acorn and Mutine, all of which will be ready for service in the course of March. These five vessels represent an aggregate of twenty-five guns and 5540 horse-power.

The "Mutine."—The Mutine went out on Wednesday for a trial of her machinery, after repairs. Annexed are details of the trial: Draught of water, forward, 11 ft.; aft, 15 ft. 6 in.; steam in boilers, 60.5 lb.; mean steam pressure in cylinders, high, 32.5 lb.; low, 12.6 lb.; vacuum in condenser, 26.3 in.; revolutions of engines, 160.5; indicated horse-power, high, 535; low, 576; total, 1116; mean speed, 12.87 knots.

Gas at Cardiff.—The half-yearly meeting of shareholders in the Cardiff Gaslight and Coke Company was held on Wednesday at Cardiff. Mr. C. H. Williams presided. The directors, in their report, stated that in consequence of the rapid growth of the town and neighbourhood, the company's business showed a large and satisfactory increase, necessitating, for future requirements, an additional outlay in extending the producing plant at the Grange Works. They recommended a dividend for the half-year of 10*l.* per cent. per annum on the "A" stock, 8*l.* per cent. per annum on the "B" stock, and 7*l.* per cent. per annum on the "C" stock and shares, created by the Act of 1870.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—There was a stronger feeling in the pig-iron warrant market last Thursday in consequence of the more generally expressed determination amongst ironmasters to stop their blast furnaces rather than concede an increase of wages to their miners. So long as the price of pig iron was up at 46s. or 47s. per ton, the desire was to blow in more furnaces, but since prices have fallen as low as 44s., the propriety of reducing the output and the stocks has been freely suggested. In last Thursday's market the continued anxiety regarding the issue of the miners' strike caused "bears" to buy so as to cover recent sales, with the result that prices advanced. Scotch iron was largely oversold, and the closing quotation, 43s. 10½d., showed a gain of 7½d. per ton over that of the previous day, and a recovery of the decline of the previous three days. Cleveland warrants closed at 36s. 6d., being 6d. over the close of the preceding day, and hematite warrants recovered in price 6d. per ton, though still 9d. under the closing quotation of the preceding Friday. Prices weakened on Friday, and there was a smart decline from the buoyancy of Thursday. The price of Scotch iron advanced in the early part of the day to 44s. 1d., which was the best over the week, being 10½d. above the lowest quotation on Wednesday; there was then a pressure of stock, and prices declined to 43s. 8½d., but closed at 43s. 9½d. cash. No transactions took place in Cleveland iron, but buyers offered 35s. 6d.; hematite iron changed hands at 48s. cash, the closing price, however, being 47s. 7d., showing a fall over the week of 11d. per ton. The tone of the market on Monday was somewhat more favourable, as the political and commercial reports from abroad were decidedly more satisfactory, while there were reports of larger shipments of pig iron and of an easier and better supplied coal market. Holders of iron became very firm, and latterly they secured some good advances. In Scotch iron there was a recovery in price up to 44s. 3d., at which the market closed with sellers, showing a rise of 5d. from Friday's closing quotation. An advance of 3d. per ton was made in the price of Cleveland warrants, and hematite warrants improved 5d. per ton, the close being at the best price, 48s. The firmness continued yesterday, and a further advance was made in prices, especially of Scotch iron, which was largely dealt in. Up to 44s. 7d. cash was paid, the close being at the best. A rise of 3d. per ton was made on the price of Cleveland warrants, but at the close hematite iron showed a decline of 1½d. per ton, which was chiefly owing to the week's increase of stocks being very large. There was an advance in the price of pig iron all round this forenoon, but at the close in the afternoon the prices were—Scotch warrants, 44s. 4d. cash; Cleveland, 36s. 1½d.; hematite, 47s. 9d. sellers and 47s. 7½d. buyers. Owing to the miners' strike and the limitation in the output of coal, there are no fewer than fourteen blast furnaces damped down, so that there are now only 60 in actual operation, as compared with 94 at this time last year and 92 two years ago. The weekly make of pig iron is thus reduced to the extent of probably upwards of 3000 tons, and it is about 7500 tons less than it was a year ago. Last week's shipments of pig iron from all Scotch ports amounted to 8063 tons, as compared with 6330 tons in the preceding week, and 5866 tons in the corresponding week of 1886. The United States took 1375 tons; Australia, &c., 395 tons; France, 118 tons; Italy, 540 tons; Holland, 200 tons; Spain and Portugal, 100 tons; China and Japan, 100 tons; other countries took smaller quantities, and 4427 tons were sent coastwise. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood yesterday afternoon at 845,219 tons, as against 843,601 tons yesterday week, showing an increase for the week of 1618 tons.

Important Contracts for Kilmarnock.—A very large order for the supply of water meters to Naples has just been placed with the Kennedy Water Meter Company, Kilmarnock. The value of the contract is estimated at about 60,000*l.*, and the supply of the meters will extend over several years. The Glenfield Company, whose works are contiguous to and connected with the Meter Works, have recently secured an important contract for pumping engines for New Zealand.

Glasgow Students of the Institution of Civil Engineers.—Last Saturday afternoon the Glasgow Association of Students of the Institution of Civil Engineers paid a visit to the new works at Mugdock connected with the extension of the Loch Katrine water supply to Glasgow. The visitors were received by Mr. Jarvis, the resident engineer, who conducted them over the works, and described the chief features of the new reservoir and the new tunnel. On account alike of the nature and magnitude of the works, the visit proved most interesting and instructive.

Opening of the New Tay Bridge.—The opening of the great engineering structure across the Tay, which is now well-nigh finished, has lately been under the consideration of the directors of the North British Railway Company. While feeling that it is yet too early to fix the date definitely for that auspicious event, they entertain the hope, and indeed consider it very probable, that everything will be ready to permit of the opening taking place on the 20th June, when the Queen's Jubilee will be celebrated.

The Proposed Extension of Buckpool Harbour.—The Buckpool Harbour Commissioners, having resolved to proceed immediately with the completion of the surveys in connection with the enlargement of the harbour, Mr. Willet, Aberdeen, the engineer for the harbour improvements, has recently been engaged, along with three assistants, making surveys and taking soundings, with a view to the completion of the Board of Trade's schedule, preparatory to contracting for the works, which are expected to cost upwards of 19,000*l.*

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Water Cartridge Experiments at Carton Wood.—The men employed at the Carton Wood Colliery have just witnessed some experiments in the mine with water cartridges. Five shots were fired, and in each case all the men were conducted to a place in the mine where it was impossible for any light to appear, so that the blasting was in perfect darkness, and in each case the deputation frankly admitted that no flash or signs of fire had been witnessed, and that scarcely any smoke was visible, there being only a slight smell arising from the consumption of the 15 per cent. of "wood meal," which is part of the composition of the material.

Improvement of the Ouse Navigation.—The York City Council has by a large majority resolved to carry out the scheme of Mr. Fowler for improving the navigation of the River Ouse, at an estimated cost of 11,400*l.* The scheme includes the formation of a new lock at Naburn.

Proposed Railway through Dovedale and Ashbourne.—Influential meetings are being held in the districts around Dovedale and Ashbourne to promote a railway from Ashbourne to Buxton. Professor Sheldon, Rev. W. H. Purchas, vicar of Alstonefield, and other landed gentlemen, have been most energetic in obtaining assistance. If constructed, the line would run through a rich agricultural district, teeming with great mineral wealth.

Hull and Barnsley Railway and Dock Company.—The report of the directors of this company, for the half-year ending December 31, states that the accounts for the half-year show a gross revenue from all sources of 92,062*l.* 5s. 3d. The working expenses have been 65,583*l.* 10s. The directors think there is cause for congratulation in the improved earnings and prospects of the company. Ships of a total tonnage of 316,547 tons have entered the Alexandra Dock during the half-year. The directors regret that the negotiations, initiated by them with the Hull Dock Company with the object of agreeing upon an equitable scale of changes for all services rendered in the respective docks, and to obtain access to the Hull Dock Company's estate, have not been carried to a successful issue. The counter-propositions, made by the Hull Dock Company, involved conditions, which, in the interest of the proprietors, could not be maintained. The directors having been unable to raise the necessary capital by issue of preference stock, authorised by the Act of 1886, have been compelled to devote the net revenue of the company as it accrued to the payment of rolling-stock instalments, interests on land purchases, and other urgent necessities in lieu of the payment of debenture interest. An order has, in consequence, been made in the Court of Chancery, at the instance of the debenture holders, for the appointment of a receiver on their behalf. Subject to this appointment, which has not yet been made, Colonel Smith and Mr. Swarbrick have been appointed receivers and managers of the company for the judgment creditors in the action brought by Messrs. Shelford and Bohn.

Scarborough and Whitby Railway—Unsatisfactory Prospect.—The directors of this company have just issued their report for the half-year ending December 31 last. The surplus to be carried to the net revenue account is 2168*l.* Amongst other things, the directors say: "As stated in previous reports, your directors have still to express their great disappointment at the management of the North-Eastern Company, more particularly with reference to the want of a quick through train service between Scarborough and Middlesbrough, the merely nominal character of your goods traffic, and the retention of your valuable surplus lands at Scarborough. These, and other similar instances, taken together, leave no room for doubt, in the opinion of your directors, as to there being an absolute and incontestible failure on the part of the North-Eastern Company to fully develop your traffic, or to act in accordance with the spirit of the working agreement. Your directors consider that if the company's undertaking had received fair play, its earnings would at least have been sufficient to pay a dividend upon the new preference stock. This, however, has not yet been the case, and consequently, to their great regret, they have found it impossible to dispose of the unissued portion of that stock at par. As, however, they are bound to make provision, so far as circumstances permit, for payment of the balance remaining due to the contractors, they feel that the issue of the remaining portion of the company's preference stock cannot properly be delayed longer. The contractors, to whom a large sum of money is yet due, are willing to take the stock at the price of 50*l.* per cent. of its nominal value, and your directors are of opinion that it would be expedient to issue it at this price, if no better can be obtained.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the market was firmer, and No. 3 g.m.b., f.o.b. Tees was quoted 35s. 9d. per ton for prompt shipment, and 36s. 6d. for delivery up to June. The latest advices from America and the Continent are of a satisfactory character respecting the iron and steel trades, and the prospects of an enlarged demand are reassured. The colonies, too, but more particularly India, are ordering railway material freely, and some important contracts are now in negotiation. Shipments of pig iron at Middlesbrough up to date this month are better, there having been exported 41,300 tons as compared with 25,700 tons to same time last month, and 36,700 tons at corresponding period last year. Hematite pig iron is steady at 48s. to 48s. 6d. per ton for Nos. 1, 2, and 3 f.o.b. east coast ports. Manufactured iron is rather more in request and prices are steady. Ship-plates are quoted 4*l.* 17s. 6d., angles, 4*l.* 12s. 6d.; steel ship-plates, 6*l.* 5s. to 6*l.* 10s.; and angles, 5*l.* 15s. per ton, all less 2½ per cent. at works. Steel rails are selling at 4*l.* 7s. 6d. per ton.

Engineering and Shipbuilding.—Engineers and iron-founders are better employed, and shipbuilders on the northern rivers are fairly busy. Some of the latter find it difficult to obtain supplies of steel to meet their requirements. All the steelmakers continue busy, and have work in hand which will occupy them for months.

Proposed National Conference of Iron and Steel Workers.—Efforts are being made to arrange for a meeting of iron and steel workers in Manchester to consider the advisability of organising a national association of these trades for the purpose of discussing all questions of interest to them. Such an association established on a proper basis with the aid of arbitration will certainly prevent strikes and adjust wages questions without unnecessary loss to either employers or workmen, and will be welcomed in the iron and steel-making districts.

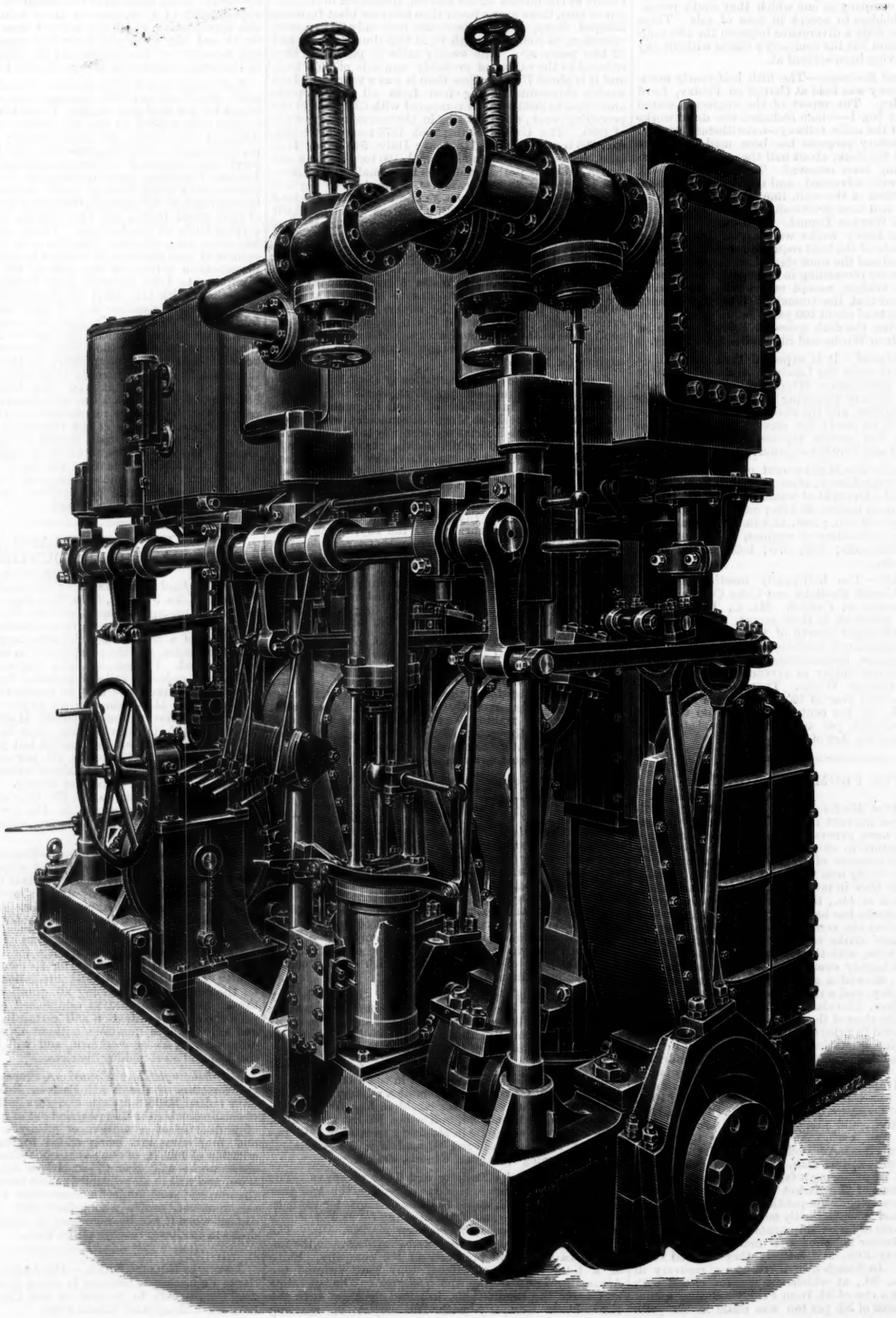
Middlesbrough Dock Extension.—Since our last notice the directors of the North-Eastern Railway Company have visited Middlesbrough and surveyed the extension of the dock which is being carried out at a cost of upwards of a quarter of a million of money. Between three and four acres are being added to the dock, and an addition of 1400 ft. of quay is made. The completion of these works will give 27½ ft. below high-water spring tides, and will in all probability meet the requirements of the iron and steel trade for some time to come. There are, however, people who believe that the day is not distant when it will be necessary to construct extensive docks in the lower reaches of the Tees.

AMERICAN ROLLING STOCK.—The Atchison, Topeka, and Santa Fe Railroad Company is about to let contracts for 2500 freight cars to be used on the Chicago extension, between Chicago and Kansas City.

TRIPLE-EXPANSION ENGINES OF THE TUGBOAT "POWER."

CONSTRUCTED BY MESSRS. NEWALL AND CO., ENGINEERS, BRISTOL.

(*For Description, see Page* 176.)



THE HAWKESBURY RIVER

THE UNION BRIDGE COMPANY, NEW YORK, ENGINEER

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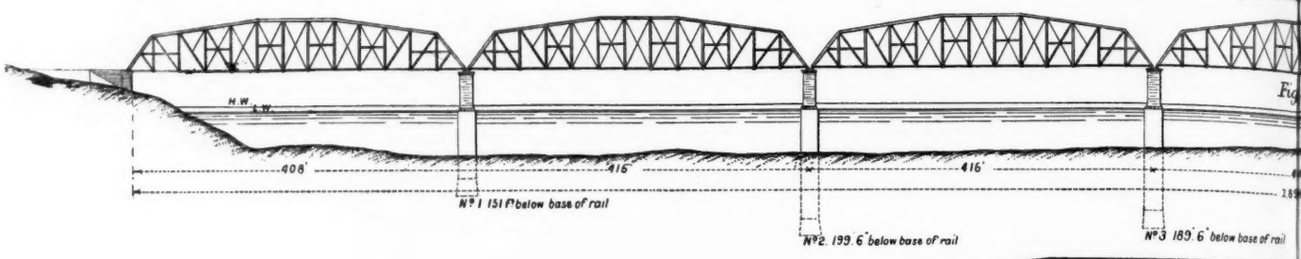

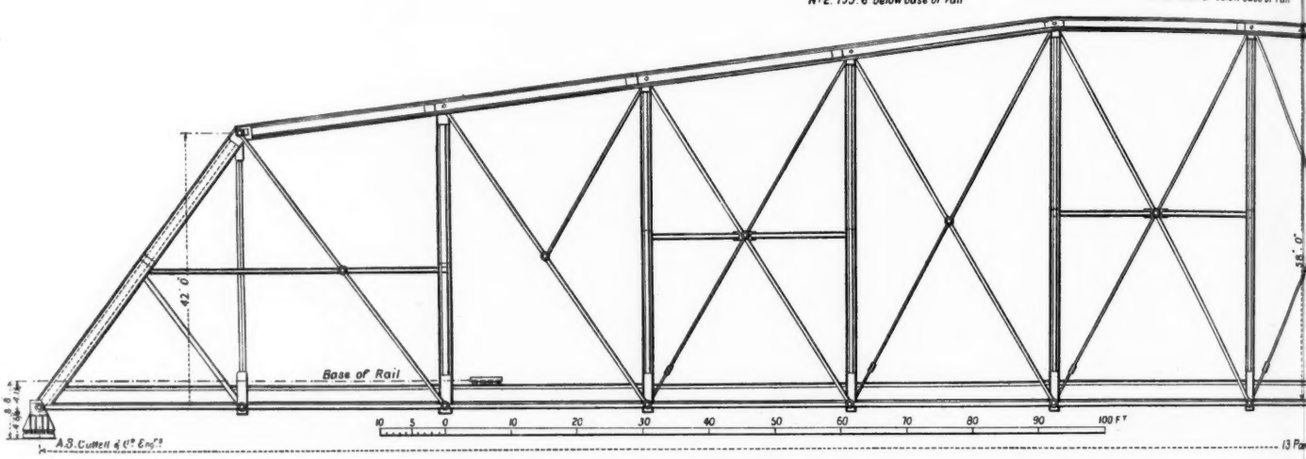

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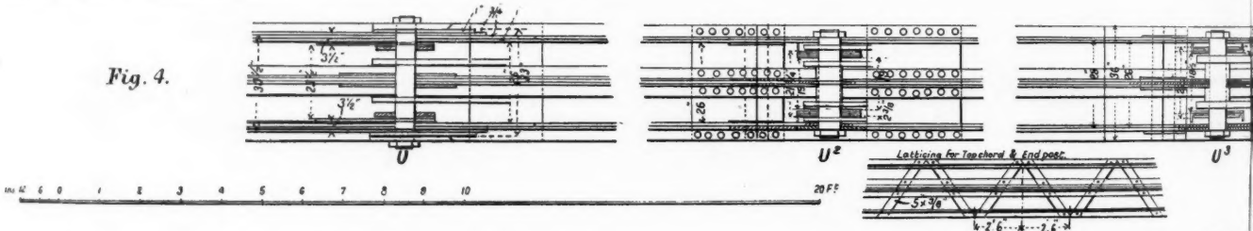

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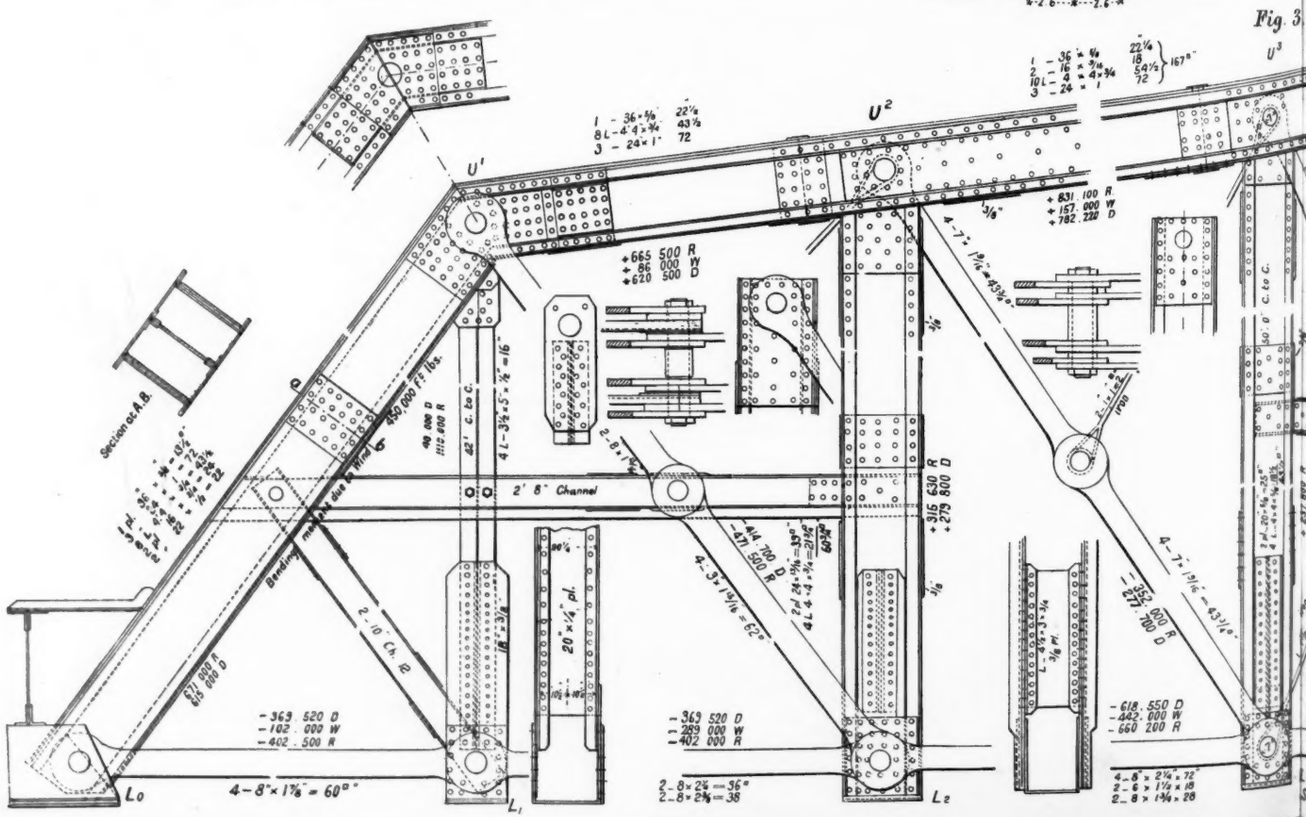

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GINEERS; SIR JOHN FOWLER, K.C.M.G., CONSULTING ENGINEER.

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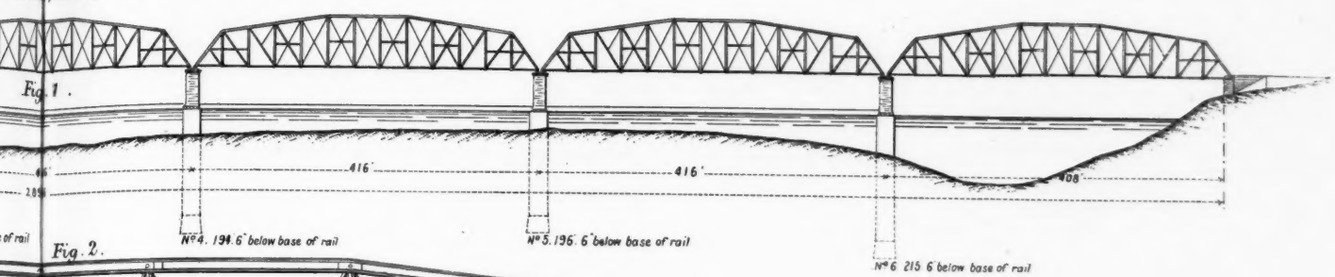

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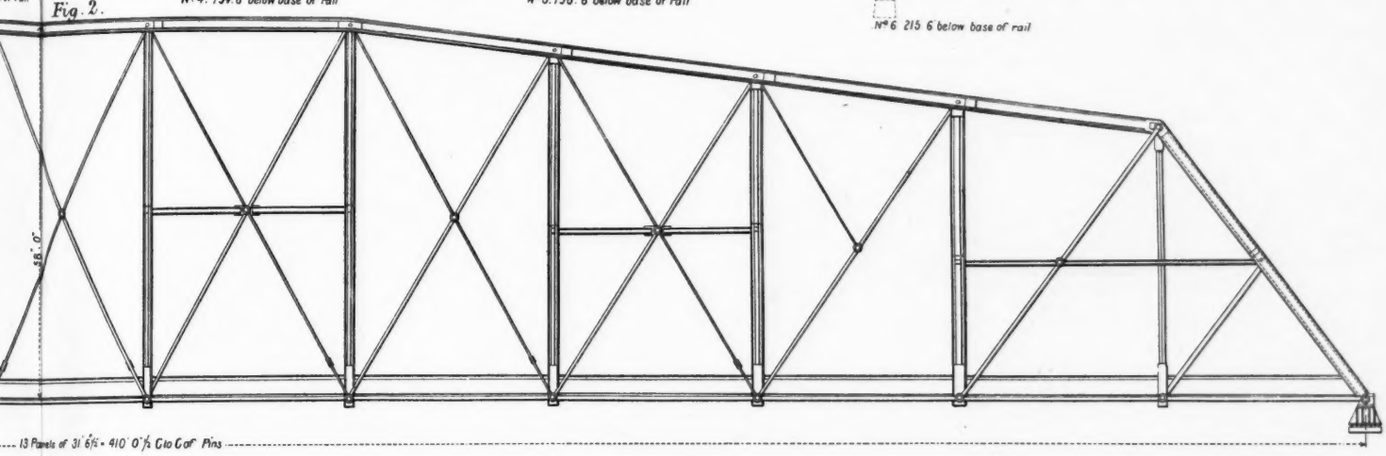

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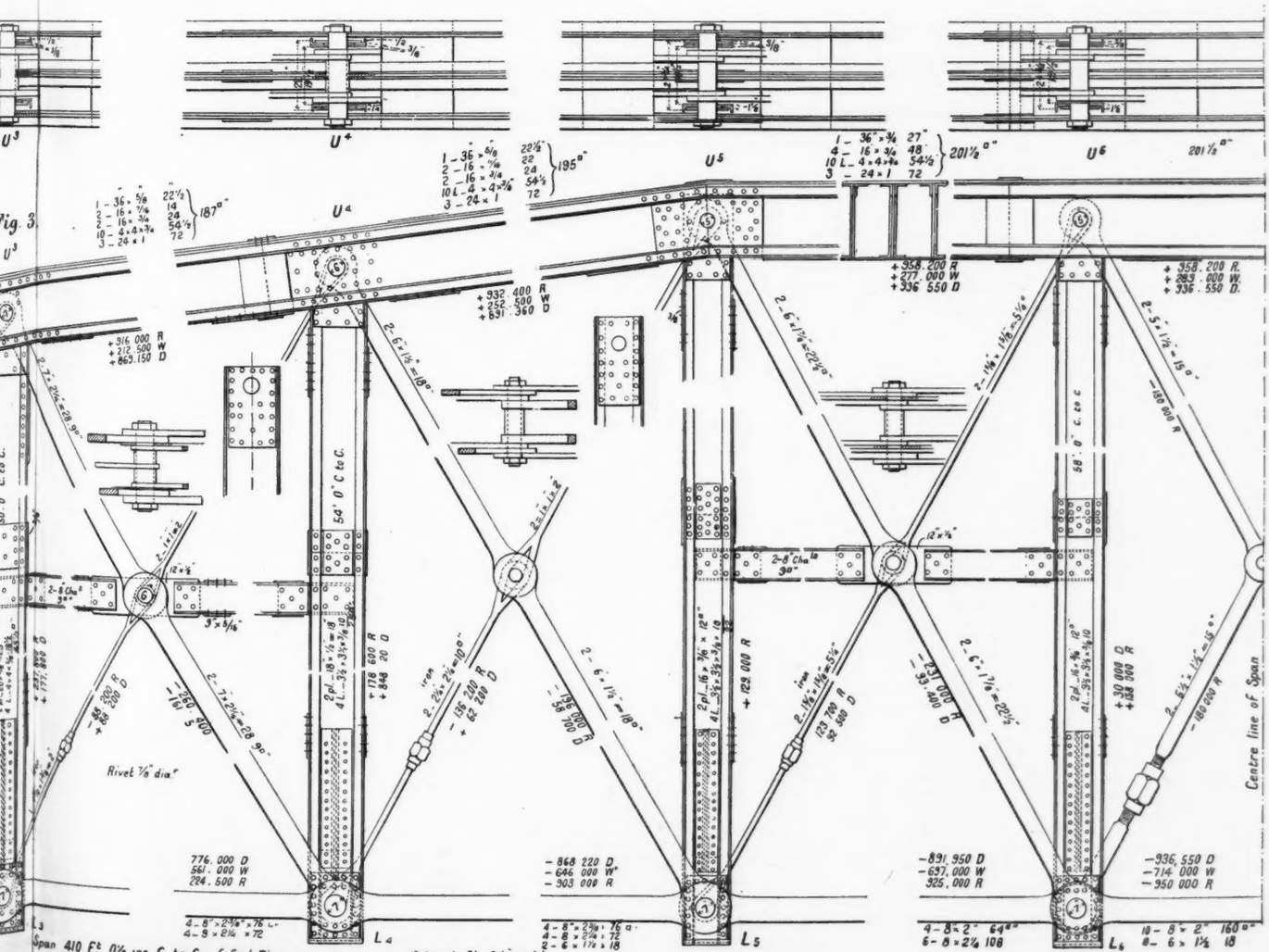

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NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Ordinary meeting, Tuesday, March 1st, at 8 p.m. Paper to be read with a view to discussion: "Dredging Operations and Appliances," by John James Webster, M. Inst. C.E.—Students' meeting, Friday, March 4th, at 7.30 p.m. Paper to be read: "Propelling Machinery of Modern Warships," by Sydney H. Wells, Wh. Sc., Stud. Inst. C.E.

CHEMICAL SOCIETY.—Thursday, March 3rd, at 8 p.m. Ballot for the election of Fellows. "The Colouring Matter of Drosera Whittakeri," by Professor Rennie. "Anhydracetonebenzil," by F. R. Japp and C. F. Burton, B.Sc. "Condensation of Benzil with Ketones," by the same. "The Constitution of Glycosine," by F. R. Japp and E. Clemenshaw, M.A. "Diphenylglyoxaline and its Homologues," by F. R. Japp. "Dehydracetic Acid," by Dr. W. H. Perkin, Jun.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Wednesday, March 2nd, at 7 p.m., at 7, Westminster Chambers, S.W. Ordinary meeting, when a paper will be read by Mr. B. Haughton, on "Wave Percussion."

ENGINEERING.

FRIDAY, FEBRUARY 25, 1887.

SHIPPING LEGISLATION.

THE lecture of Mr. Thomas Gray, C.B., delivered last week at a meeting of the Shipwrights' Company, is pleasant reading. We have grown so accustomed, within the last year or two, to hearing everything that is unpleasant about ships and shipping, looked at from any point of view other than engineering or construction, that it is refreshing to find there is so much upon which we may congratulate ourselves.

In the lecture in question, the fifth of the series promoted this winter by the Shipwrights' Company, a period of fifty years is embraced, and the state of our mercantile marine at the commencement and end of that period is well contrasted, showing what improvements have been effected by legislation. It has been pointed out by a contemporary that Mr. Gray was to a very great extent reviewing himself, for he inspired and promoted a great part of this legislation.

We will, however, commence with a few of the lecturer's invigorating statistics so as to help those of the shipping community to realise how remarkably much better off they are than were their forefathers. "Now, to begin," says Mr. Gray. "In 1836 there were 25,820 ships on the register of British ships, and their tonnage was 2,792,646 tons; of these 600 were steamers of 67,969 tons. In 1886 there were 38,335 ships on the British register, and their tonnage was 9,323,615 tons, of these 8913 were steamers of 4,293,115 tons." Taking the steam ton as worth four sailing tons the author gets the following results: Year 1836, 2,996,553 effective tons; year 1886, 22,202,960 effective tons. These figures are pretty reading, and Mr. Gray points to them in triumph as the effects of his legislation. There is one branch of the shipping community to which the swelling totals may not be altogether eloquent of triumph and joy. Shipowners would just now gladly see the twenty-two million odd "effective tons" pared down by so much as would represent the numerous vessels laid up at present in pretty nearly every snug anchorage or quiet mooring place in the kingdom. This, however, is but an incident in the march of progress, and the age is far too busy and practical to be able to spare sympathy for so common-place an individual as the capitalist who has overshot the mark.

Mr. Gray next proceeded to give us a picture of the state of shipping at the commencement of the period he treated of; before it was released from "the rags and tatters of protection in which it was clothed," and before seamen were raised "from the Slough of Despond in which, and the tyranny under which, many of them dragged out an existence." For 1836 then we must picture to ourselves: "When British ships were classed by Lloyd's solely on age, or according to port of building" (when there were no Lloyd's surveyors, and England was merry England still to the unvexed soul of the British shipbuilder); "when protection of British shipping existed as against foreign ships, and when British colonial ships were excluded from many foreign ports, and others were admitted only on paying a *surtax de pavillon*; when British ships were so slow that British shipowners feared free trade because successful competition with foreign ships was impossible; when harbours were so shallow that the bottoms of ships had to be specially constructed to take the ground; when drunkenness and incompetency among the ordinary run of officers as well as of seamen was notorious; when charts were notoriously inefficient; when there were no lifeboats nor rocket apparatus; when the mercantile marine largely depended for seamen on pauper apprentices; when there was no examination of masters, mates, and engineers; when numerous lighthouses were the property of, or leased to, individuals, and when surplus light dues went to purposes unconnected with shipping; when harbour dues, town dues, and charity dues, and passing dues levied on ships, were also frequently appropriated to many purposes not solely connected with shipping; when there were practically no harbours of refuge, though a passing toll had to be paid by all ships passing Whitby, Bridlington, Dover, or Ramsgate; when there were scarcely any docks; when the Tyne, Clyde, and Tees were navigable only to small vessels even at high water; when freight was the mother of wages; when payment for salvage of life was unknown; when ships did not carry side lights; when there was no international rule of the road by sea; when no reports of wrecks were required to be made; when no inquiries as to wrecks were held; when the press gang was in full work; when crimps preyed, and preyed unchecked on British seamen; when there were no savings banks nor seamen's money order system; when there was no system for recovering the wages and effects of deceased seamen; when the only seamen available for augmenting the Navy in emergency consisted of undrilled men of the mercantile marine; when there was no statutory provision as to the supply of food, or as to the accommodation of seamen; when there were no checks to the tyranny of masters and mates at sea, no provision for the proper execution and enforcement of contracts between masters and men; no naval courts, &c.; when one ship was not required to stand by another ship after collision; when a seaman could not raise any question as to the unseaworthiness of his ship, but could be sent to prison as a deserter if he went ashore to complain; when there was no international or commercial code of signals."

This is a pretty long list of things wanted to be done; but we have not space to follow Mr. Gray in his interesting account of how, by legislation, many of these evils were removed. It is hardly necessary to say, in spite of our national dislike to grandmotherly legislation, that the benefit to all classes from the salutary laws passed has been immense. The most robust *laudator temporis acti* would hardly claim that we have not improved since those early days of fifty years ago.

The bad effect of the old tonnage laws on the design of ships formed a proper part of Mr. Gray's lecture, but the evil is yet too well remembered for our readers to require any reminder of it. The question of legislation on the subject of emigration is, however, still invested with interest. The number of emigrants carried by British ships during the last thirty-three years is 5,505,965, and the statutes relating to their accommodation were devised to meet the requirements of the old wooden sailing ships, and are quite unfit to the fast steamers of modern times. This Mr. Gray showed by details as to duration of voyages and other particulars he quoted.

On the whole, it cannot be doubted Mr. Gray made out an excellent case in favour of past legislation. Whether that has been the best that could have been devised is a question that need not be discussed. It is easier to criticise than to create, and easier still to be wise after the event. Mr. Gray might, however, have made his case still stronger by supporting it by some facts he afterwards brought forward. In old days there was at any rate the responsibility of personal ownership to hold in check abuses; and though consciences might have been tough and evil deeds kept dark, the owner was at any rate a tangible entity. Now, however, we have the Limited Liability Acts creating for us corporations with neither souls to be damned or bodies to be kicked, and in few cases does the aphorism more fitly apply than in "single ship" companies. Mr. Gray's description of a typical undertaking of this sort is so humorously expressed, and yet has so much truth in it, that we will quote his words at length. He called it "The story of the seven honest but clever clerks." These benefactors of their kind, Mr. Gray tells us, "may convene a meeting of themselves, they may, in ready money, possess wealth to the amount of 10*s.* each. Having met, they say, 'Let us help our neighbours who have money, and let us be not unmindful of ourselves; therefore let us set about and form a company, whose liability shall be limited by shares, and let its name be the Single Ship Company. Let the capital of this company be £ sterling, amounting to five figures, in shares of 10*s.* each. We may each subscribe for one share. We may raise the sum for preliminary expenses, and, as a last resource, we can make use of a commercial expedient and 'do a bill' at three months for 30*l.* which will suffice. I, A. may say, will be the managing owner; I, B. may say, will supply stores; the others, C., D., E., F., and G., also obtain their chances so that all may be fair between them. Now A., who is the managing owner, may say, let us in our Articles of Association be cautious, so that in case there shall be loss, whoever else may lose, we shall profit by this

adventure. Therefore, let us stipulate that the managing owner shall receive a commission on gross freight and on all payments and receipts. Let us be indefinite as to our obligations to render details in accounts to anybody, and let us take care that the ship is thoroughly covered by insurance, and let us also take care that the managing owner has absolute and sole control to run the ship in any trade he likes, and to replace her if lost out of the money paid by the assurers. When a builder may be found who will proceed on business principles on a small cash payment, and when the outside public take up the shares, our scheme will be complete. We shall be instruments in the spread of the British mercantile marine. We shall be encouraging the trade of the country; and above all we shall not have been unmindful of our own interests."

In this way, as Mr. Gray points out, a ship may be built by the money of people who pay no sort of regard to Articles of Association until they fail to receive interest on their money, "and who no more need a ship or a share in a ship," as was stated by "Fairplay," "than they need a boa-constrictor."

The particulars Mr. Gray quotes on the status of seamen are full of interest, but are too voluminous to follow. Although much, very much, remains to be desired in Mercantile Jack, yet he is a better, certainly a more sober and thrifty fellow than of yore. Nevertheless, we are told, he has not advanced so much during the last fifty years, as other members of the wage-earning classes here.

Mr. Gray concluded his interesting lecture with some remarks on the loss of life and loss of property through shipwreck. The subject is one that has happily ceased to rouse so many angry retorts and recriminations as it did a short time ago. Looking back to that period it may almost be wondered where the cause of so much feeling arose. In some of Mr. Gray's remarks we fancy there is an echo of that controversy still lingering; not that he shows any undue warmth himself, but there is the suspicion of an attitude of defence and justification. Although every honest and humane man must applaud any endeavour to prevent human life being sacrificed for the ends of gain, or as Mr. Gray puts it, "the counters with which the shipowner plays his game of trade being made human lives," yet in spite of this laudable endeavour, no excuse is made out for scattering broadcast inuendoes and accusations unsupported by fact.

There is yet another aspect of the case that must not be lost sight of in discussing this matter of shipping legislation. "Property," says Mr. Gray, "can take care of itself." Very true if you give property a chance, and leave it in peace. But without property, *i.e.*, ships and their use, neither can the seamen exist. Some time ago, in the House of Lords, a certain noble lord said he would rather exist as a match pigeon and be shot at than be nothing at all. Mr. Gray has often drawn a pathetic and, alas, too true a picture of the sufferings of poor Mercantile Jack. But there is just a chance we might let our sympathy for the sailor's hard lot legislate him out of existence. British shipowners now labour under many statutory disadvantages that do not apply to foreigners, and if the burden be made too heavy, commerce will go to other flags. There may be little prospect of that at present, but the House of Commons is an emotional body, or rather is obliged to follow an emotional public opinion, and legislature produced under such circumstances often goes to extreme lengths.

MICRO-ORGANISMS AND WATER.

Bacteriology as a science is hardly two decades old. Records of a much earlier date of real experiments on the possibility of low life are, however, not wanting. In 1769 Spallanzani filled bottles with infusions of various kinds, sealed them, boiled them, and waited for the appearance of growth, not in vain. Gay-Lussac and others had asserted that life without oxygen was impossible. By the middle of this century "spontaneous generation" and "catalytic action" had become favourite topics, the latter term comprising a group of heterogeneous phenomena supposed to be due simply to the presence of certain bodies, the ferments, for instance, which in themselves were said to be left unchanged. Pasteur's "Etudes sur le Vinaigre" of 1868 destroyed these illusions, and at the same time introduced to the manufacturer certain very tiny organisms as his powerful friends or enemies. Pasteur's first protégé was Mycoderma aceti. At present we possess a stately number, ever increasing, of micro-organisms, and general conclusions from the peculiarities of one are no longer indulged in. They are all exceedingly small; for the single individual or what appears to be a single cell at a certain stage—for they contract and divide, split transversely and form spores—0.01 millimetre or $\frac{1}{2500}$th of a unit is a fair size. Ordinary illustrations represent them, with a magnifying power of 500 and 700 and more, as thick as pins'-heads perhaps, but often much longer; and sometimes they cruelly deceive the observer by standing on their toes or lying on their curved bellies when they are expected to display their curved or spiral shape by decently lying on their sides. They have their characteristic forms. Cohn believes they may pass through a cycle of forms. The Coccus are round; the Bacteria proper are rods which may or may not thicken when developing spores; Spirobacteria (bacillus comma, vibrio, spirillum) show curves and spirals. Sarcina, most unwelcome to the brewer, and some others, are distinguished by the tetrade form; they first assume the shape of dumb-bells, then subdivide twice, forming conglomerates of four and eight; some aggregate to long chains. Very troublesome are the liquefying colonies, which transform the gelatine in which they are kept into a liquid mass; in test-tube cultivations, for instance, to be mentioned afterwards, the path of the platinum wire in the gelatine becomes marked by a funnel of liquid gelatine.

That these micro-organisms play a most important *rôle* in the economy of nature, has long been established. But, according to Dr. Klein, a great deal of our knowledge is real and a great deal imperfect. First, with regard to chemical changes. The putrefaction of proteids is due to bacteria, doubtless; during this process, there result peptones, leucine, and tyrosine, and cognate bodies; then ptomaïnes, bodies of the nature of the alkaloïds and decidedly poisonous; finally ammonia, sulphuretted hydrogen, &c. But it has not been shown yet whether this whole series of changes is due to one kind of microbe. In some cases we have distinctly different organisms for different changes; and they exhibit an extraordinary selective power with regard to their food. A sugar solution left to itself will soon assume a condition abhorred by a teetotaller; and after awhile again become harmless to his principles although by no means to his digestion. Of the many organisms probably present in the nasty liquid, it is one only, Saccharomyces cerevisiæ (yeast), which converts the sugar into alcohol; then another steps in, Mycoderma aceti, and changes the alcohol into vinegar. Clostridium butgricum is pernicious to the wine-maker, as also Bacillus lactis which turns milk sour. Any putrefying matter teems with Bacterium termo, and when the putrefaction has ceased, these microbes have disappeared; but it is probable that the process is a complex one. Hippö, a fermented milk drunk in the Caucasus, was supposed to be the fermentation product of Dispora-caucasica; this organism is probably, however, simply an accidental concomitant.

The connection between disease and micro-organisms is a well-known fact; everybody is afraid of germs. Micro coccus abound in mucous membranes of people suffering from scarlet fever, in diarrhœa secretions, &c.; but no scarletinic or diphtheric bacillus has as yet been isolated. But Bacillus anthracis (characteristic of splenic fever) and Micro-coccus tetragonus are undoubtedly the cause of specific diseases; the chain of evidence seems more complete for tuberculosis and leprosy, although Dr. Crookshank believes that cases of the former have occurred where no tubercle bacilli were present. The Cholera bacillus remains doubtful. In their investigations in Egypt, Calcutta, and France, Drs. Koch, Gaffky, and Fischer came to the conclusion that a certain bacillus, smaller than the tubercle bacillus was, if not the cause, certainly characteristic of Asiatic cholera. Klein, Gibbes, and Lingard, who made an inquiry* into the etiology of Asiatic cholera at the instance of the Secretary of State for India, differed strongly; their bacillus is not like a comma, does not link together to form an S, is not found in the ileum (intestines) of victims if the examination takes place immediately after death; but occurs in the mouths of healthy persons, and water contaminated with it does not generate cholera.

* Proc. Roy. Soc., February, 1885,

Some microbes are quite harmless, undoubtedly; the authorities responsible for the disposal of our sewage never fail to emphasise this. A moderate number of the malignant species even may not be dangerous unless circumstances are favourable for them, and there is no reason why circumstances ought to favour these organisms particularly; they cannot live unless they have their proper food, and some seem to have very particular tastes. But why should they be so pernicious, when their substance is often quite insignificant compared to the bulk of the body in which they dwell? Several causes may co-operate. First they want food, and destroy delicate cells to gain it; then they interfere with the action of our organs, the kidneys for instance; their secreta may be obnoxious; they may deprive certain complex bodies of their oxygen, and they may produce the poisonous ptomaines. We can also conceive that certain constitutions—not necessarily delicate in general—are specially endangered. Orth and Wyssokowitch proved that the injection into a rabbit of Staphylo coccus was harmless, but became fatal when a slight mechanical injury had been done to heart valves.

That the authorities do not rarely disagree will not surprise us when we inquire a little into the methods and means of bacteriological study. The microscope upon which the examiner chiefly relies, unless he be a pathologist too, requires special auxiliary apparatus and particular care. The object, with its glasses, may have to be immersed in oil or glycerine to impart to the surrounding medium the refractive power of the glass; heating and particular illumination of the stage may be necessary. As the organisms are transparent, or at least translucent, they would escape detection, if most dead bacteria did not take colouring matter, gentian, aniline dyes, &c., so that they can be readily distinguished from accidental precipitates, and also from one another, as different species favour different colours. The process may be, for instance: successive treatment with aniline red, nitric acid, alcohol, and vesuvine. Fortunately the spores have proved most accommodating; they do not take aqueous or dilute alcoholic dyes, but Koch succeeded in staining them by other reagents.

In general, microscopic examination is preceded by cultivation, the object being to isolate one kind. A little of the infected substance is introduced into a nutritive material, a trace of the growth introduced into another sample, and the process repeated until after perhaps a hundred cultivations only a uniform culture of one kind is obtained. The first requirement is that all further contamination from outside and the materials to be used is excluded; everything has to be sterilised, that is, all organic substance killed. The experimenter should wash his hands with soap, corrosive sublimate and—to avoid the use of a towel, which may be of questionable service in more ordinary cases—with alcohol and ether, letting the ether evaporate on his hands. The glasses, platinum wire, &c., are heated. The nutritive materials are also sterilised by heat. A temperature of boiling water is now generally deemed sufficient to kill all microbes and their spores; Fitz and other experts go higher. Gelatine, which will not bear so high temperature, is subjected to Tyndall's discontinuous sterilisation, that is, it is heated to about 70 deg. Cent. (158 deg. Fahr.) for ten minutes on several consecutive days; the spores develop first and are then more easily destroyed. If Miquel and Van Tieghem are correct, however, that certain spores require a week to develop, this operation would not be reliable. As nutritive substances the so-called universal liquids, containing tartrate of ammonia, sugar phosphates, &c., served first; later, on Miquel and Loeffler's recommendation, broth, was preferred. Of solids, slices of white of egg and potatoes, on which Bacillus violaceus produce spots like red ink spots, are used. For microscopic examination and for other reasons also, Koch's gelatine, or agar-agar, is most convenient, and is specially suited for experiments in incubators, mixed with peptone, &c.; the organisms are introduced into the liquid gelatine, which congeals on the glass plate, separating to a certain extent the various organisms and giving rise to different colonies which are counted afterwards. When the numbers of microbes are stated it is generally these colonies which are meant. In Naegeli and Koch's test-tube culture, a platinum wire is used to introduce the trace of organisms into hard gelatine contained in a test-tube and plugged with cotton-wool, which filters off all germs floating in the air.

The pathologist is not satisfied even with the pure

cultivations. He inoculates the respective organism into the system of an animal, to see whether it is productive of the characteristic disease; and naturally, the establishment of the connection between germ and disease requires this. Experiments of this kind fall under the vivisection law, which is often enough decried and ridiculed. If some of the advocates of vivisection knew, or chose to know, what senseless, stupid, and unnecessary cruelty is inflicted abroad upon thousands of animals, whose pain might often be mitigated by a little care, by thoughtless students and unfeeling professors, they would perhaps see that scientific enterprise sometimes stands in need of restriction.

It is clear that the value of these investigations will depend greatly upon the care, skill, and conscientiousness of the experimenter, and further, upon accidental circumstances. Dr. Klein holds that the danger from contamination through the air is generally underrated. Miquel made experiments extending over five years at Montsouris and at Paris, a few also in London, on the number of microbes in the air. As averages he found in spring, summer, autumn, and winter respectively 495, 650, 380, and 200 per cubic metre. In Paris the average was much higher, 3480; the year 1884 proved much healthier, owing perhaps to better scavenging. In one instance he found 97,000 in Paris. Dr. Percy Frankland,* exposing his tubes on the roof of the Science Schools, South Kensington, discovered 35 colonies in 10 litres of air; 279 per minute fell upon one square foot exposed. Reigate and the vicinity of Norwich gave much lower figures—17 and 79; Hyde Park proved better than South Kensington, but inferior to the country. For higher strata the numbers appear considerably less; at the base of St. Paul's, the stone gallery and the golden gallery, he found respectively 56, 29, and 11. In inclosed spaces, with little or no aërial commotion, the number is very moderate, but draughts, motion, &c., stir them up; these observations agree well with those of Professor Carnelly, to which we referred in our columns on the British Association meeting at Birmingham, 1886. A contamination of the air through the microbes in the water does not appear probable unless the water is agitated as in fountains, cascades, and on the coast; the dust from the dry banks is more dangerous.

How do the microbes behave in water? Dr. Percy Frankland has published a series of researches into this question.† He had already shown in 1885 that the micro-organisms in a few drops of urine introduced into distilled water multiplied extraordinarily; after hours 0, 6, 24, 48 he found per cubic centimetre 1073, 6028, 7262, and 48,100 colonies. Leone observed that five multiplied to half a million in Munich water within five days. Dr. Frankland found that in frosty weather they do not increase much; at ordinary temperature, not much either, on the contrary, they decreased slightly; but at 35 deg. Cent. (95 deg. Fahr.), a temperature generally favourable to these organisms, they multiplied enormously at first, to decrease afterwards. These tests were made with Thames water, both filtered and unfiltered; the figures do not agree so well as might be desired. The Deptford chalk well had 96 organisms — this figure is exceptionally high—against 1000 in the Thames, but they increased surprisingly to 178,000; the reason may be that just because there were only few organisms present, they found more food, although the well contains only traces of organic matter. In some cases the filtered water proved richer in bacteria than the unfiltered, also perhaps because the filtered water left the reduced number more opportunity to develop. He then introduced samples of isolated well-defined bacilli into the waters. Bacillus pyocyaneus, which produces the greenish-blue colour of abcesses, showed a slight reduction at first, then recovered and multiplied rapidly; destruction resulted only in exceptional cases. For distilled water the figures were after 1, 2, 20, and 50 days 6100, 203, 276, 100,000, always per cubic centimetre; for Thames water after 1 and 3 days: 3900, innumerable; for well water similar; for sewage after 1, 3, and 15 days: 2900, innumerable, 500,000. How much depends upon circumstances was shown by the behaviour of Koch's Comma spirillum, obtained from Berlin. It would not prosper in gelatine, and such samples did not survive one day; when properly nursed in broth, however, it kept alive in distilled water for nine days, lived in Thames water, would not thrive in well water, but multiplied excessively in sewage. Koch kept the same kind in Marseilles water for 81 days. Another specimen, Finkler-Prior's Comma spirillum, showed great vitality in gelatine cultures, but died in all waters, inclusive of sewage (12,000 reduced to 0). The experiments will suffice to show that all rash general conclusions are fallacious. Dr. Arthur Downes* adopted a different method. He has renewed his experiments of 1877, and has kept since May, 1885, a series of tubes containing distilled water originally rich in germ life; in all cases organic life developed sooner or later on addition of nutrient material. Each tube is a microcosm, and it has been most interesting to watch how the form of bacteria first dominant became more and more feeble until it became extinct, giving way to another race. Some forms survived for fourteen months, in distilled water and at ordinary temperature. We may here mention other experiments made by Dr. Downes, together with Mr. Thomas Blunt,† although they belong to another place. A series of most careful experiments convinced them that light is injurious to germ life, particularly the violet actinic rays, but that the real agent in this case is the oxygen; the respective glass tubes were insulated, or incased in lead and kept in the dark. Professor Tyndall‡ did not confirm these observations; his insulated tubes became turbid, even those filled from the water of a cascade derived from the melting of the mountain snows in the Alps.

The conclusions to which Messrs. Crookes, Odling, and Tidy§ have come are remarkable. "In investigating the bacteriology of stored and running water—a subject extensive and novel—they have tried to ascertain the conditions for the continued existence, development, and propagation in wholesome water of extraneous morbific forms, purposely introduced therein, to learn how far they thrive or dwindle in their environment of wholesome water, and how large is the state of pollution to which water must be subject to allow of the introduced microbes sustaining their existence therein." Water was infected with peptone loaded with an active sporeless growth of Bacillus anthracis, the proportion being equivalent to the introduction of more than 100,000 gallons of similar fluid into one day's water supply. Portions of this water were introduced at various intervals into sterilised culture fluid. The results, after three or four hours of incubation, were irregular; there was growth or not, sometimes of a peculiar fluffy appearance, different from the ordinary form. When the sowing was made with distilled water which had been infected five or six hours previously, the culture fluid invariably remained unaffected; that is, the addition of this water, which was infected at one time, proved barren after a few hours. The introduced bacteria was thus not able to exist for more than a few hours. These experiments, commenced with distilled water, were followed by analogous tests with Thames water, filtered and unfiltered, with similar results; the half-hour interval proved more destructive to organisms in raw water than in filtered water. That the bacillus shows less vitality in river water than in such duly filtered "is quite in accordance with the conclusion come to by other investigators, viz., that in the struggle for existence the microbe forms proper to running water outgrow and starve out the introduced morbific forms." A natural inference is that unless cholera and typhoid germs possess much greater vitality, there is, according to Messrs. Crookes, Odling, and Tidy, no probability that they should ever trouble the London water and the Londoner. One cannot wonder that Professor G. Bischof, in a letter to the editor of the *London Journal of Gas-Lighting and Water Supply*,‖ suggests "that it would be of considerable importance if some one were plainly and authoritatively to explain the objects which Messrs. Crookes, Odling, and Tidy have in view with reference to those experiments. Remember that indifference of the public to sanitary matters—for instance, to the cleansing of water cisterns—is one of the greatest difficulties water companies have to contend with. Is that object purely scientific research, or is it intended to convey to water consumers that if by any chance typhoid or cholera germs were to gain admission to the water supply, they would become harmless after a few hours?" Mr. Bischof feels no hesitation to assert that the author's object is the former; but that it would not be difficult to point to a number of cases in which the water supply was the cause of spreading disease, and in which the contamination of the water was merely transient whilst the attacks continued. Mr. Bischof perhaps thinks of the Redhill epidemic; and one cannot help agreeing with him that premature publication is not without danger.

As long as we are not positive about these suicidal tendencies of bacteria, we strive to purify our water from them as much as possible. It is possible to remove the microbes by simple filtration, that is to say, for some limited period of days and weeks. Pasteur uses clay cylinders of excellent quality fitted with a glass cylinder as if the clay were to serve as stopper; filtration is effected by positive or negative pressure. Gypsum and biscuit porcelain have been employed with success; among the latter, Chamberland's porcelain filter ranks highest. For ordinary practical purposes, however, all these are too expensive and slow. Asbestos has not been tried so largely. Of recent asbestos filters the micro-membrane filter of F. Breyer, of Vienna, deserves mention. The filtering agent are lamellæ, of the thickness of a strong filter paper, of asbestos fibres so minute and so dense, that under the microscope they rival the microbes in slenderness; these lamellæ are fastened over a metal grating and replaced when choked up. That they are able to render excellent service has been proved by experiments made by order of the Austrian army authorities, at the Berlin Hygienic Exhibition, and other places. Of course they must become choked up like every filter; for household filters they appear excellent, and also for other purposes; whether they would answer for larger installations where a good rate of filtration and easy replacement of the lamellae are indispensable, remains to be tested.

Then there are the hosts of carbon filters, every one better than its predecessor. Carbon will do much, every chemist knows that; it will also remove the microbes. But the active period is short. After awhile the microbes will grow through everything, be it clay, cotton, wool, or carbon; and if the filtering medium contains so fine a food for these organisms as the phosphates in the carbon, the filtered water may soon begin to show more germ life than the unfiltered supply. We shall refer to this point again. The filter of Professor Bischof opens another category, as it combines ordinary filtration with decomposition of organic matter by means of spongy iron; Dr. Voelcker further recommended it for eliminating any traces of lead. The suspension of iron plates in water tanks was first proposed by Dr. Medlock, 1857. Professor Bischof took the matter up in 1875, and his filters—which also contain asbestos cloth of the ordinary kind—have attained great success for domestic purposes, at Shoeburyness and in India. A large installation of his filters was made in Antwerp* to purify the Nethe water, which is badly polluted. The water passed first through sand, then through a mixture of three parts of gravel and one part of granular iron, and again through sand, falling upon the latter beds in a shallow cascade to effect an oxidation and a precipitation of the dissolved and suspended iron by the oxygen of the atmosphere. On this bed the reddish liquid deposited a slimy mass which had to be broken up occasionally. The plant was good; but according to the engineer, Mr. Devonshire, a sort of impervious alumina and silica formed, impairing the rate of filtration, which became only one-half of the 150 gallons per square foot per twenty-four hours expected. A modification of the plant on Mr. W. Anderson's plan was then adopted. Revolving cylinders 15 ft. long by 5 ft. diameter were filled to one-tenth with iron of various forms: granular small bullets, coarse cast-iron tubing, and best of all, borings; and the water was introduced to spread radially; with one revolution per minute, they purify 500 gallons per minute and require ½ horse-power. Three of these cylinders were started in March, 1885, the former filters being used as sand beds only. The water comes out light grey, or

* Proc. Roy. Soc., 1886, page 09
† Proc. Roy. Soc., 1886, June 10

* *Nature*, 1886, July 22.
† Proc. Roy. Soc. 1877, December 6, and 1878, December 19.
‡ Proc. Roy. Soc., December 19, 1878.
§ Reports on the Metropolitan Water Supply to Sir Francis Bolton, since July, 1886.
‖ December 7, 1886.

* W. Anderson, M. Inst. C.E., Journal Soc. Arts, November 26, 1886.

when very impure dark to inky black, depositing iron, and clearing within two to four hours. Should the iron be unable to deal with the pollutions the liquid comes out purplish. Iron is inimical to all life, vegetable and animal; the eels are anxious to escape from the stream issuing from the revolvers. The chemical process is not fully understood. A solution of the iron must take place, followed probably by a precipitation by the carbonic acid dissolved and higher oxidation, at the expense of the organisms also. It is noteworthy that the filtered water contains less iron than the original Nethe water. Mr. Bischof took out a revolver patent eighteen years ago, but his researches were not encouraging, and he deems actual contact for each particle of water necessary. He further found spongy iron eleven times more efficient than borings. At Antwerp—the process is also used at Dordrecht and Gouda, and at the Creil and Co. iron works at Paris—five minutes' contact is thought sufficient. The rate is 100 gallons per twenty-four hours per square foot.

Dr. Angell sees a difference in principle in Bischof's and Anderson's process; the former is an oxidation due to the porosity of the material, the latter a reduction process as just indicated. The best filter, in his opinion, would be something like spongy platinum of enormous porosity, whose great oxidising capacity is well known, if anything similar could be produced at a reasonable cost. It is conceivable that porosity plays a more important part in our ordinary sand filter than is usually granted. In the general opinion the action of our sand filters is essentially mechanical. Granting oxidation due to porosity—the nature of such a process is not quite clear—the influence upon different organisms would not be the same; the aërobes require oxygen for their existence, some appear indifferent, and the anaërobes live only in the absence of oxygen. In all cases, however, abundance of oxygen proves pernicious to microbes; various sound schemes for the treatment of sewage are based upon this fact. Other chemical processes, not yet understood, may take place; and the struggle for existence between the microbes crowded together on and between the grains of sand may become fiercer.

Of recent researches on the filtering power of various materials, we will add a short extract from the experiments of Dr. Frankland*, made with materials, finely powdered, and passed through a sieve of forty meshes to the linear inch. A column of 6 in. was packed between asbestos layers in a glass tube of 1 in. diameter. Greensand: very ferruginous, rate of filtration 2.08 in. per hour; filtrate contained a little iron, was quite free from organisms, even after thirteen days; after one month, a reduction of 40 per cent. in the number of microbes was still noticeable. Animal charcoal: rate only 0.8 in. per hour; no organisms after twelve days; after one month, the filtrate proved five times worse than the unfiltered liquid. Spongy iron: rate 1.84 in. per hour, but decreasing quickly; after twelve days, no organisms; after one month, only two (of 1281 unfiltered). Brickdust: reduction about 70 per cent. Coke: at first no organisms at all, after five weeks still 98 per cent. reduction. Silver sand, carefully freed from all iron which might act as an antiseptic: rate 1 in. per 2 min.; reduction 90 per cent. Some tests followed in which the material was agitated with the infected liquid (urine), and permitted to subside. Here spongy iron, chalk, and specially coke gave good results; china, clay, and brickdust failed. Clarke's lime process was tested, first in the laboratory, then on a large scale with Colne Valley water near Bushey, where, however, the water which generally settles in open tanks in three hours, had to settle two days owing to boring operations; 322 colonies were reduced to 2. Lastly, Gaillet Huet's process: the water from an artesian well is mixed with lime water and caustic soda, then forced up a tower with diaphragms to hasten the precipitation of the lime carbonate; a reduction from 182 colonies (of which thirty-eight liquefying) to four colonies (none liquefying) was obtained.

Dr. Frankland concludes with the remark that these tests should be greatly multiplied and repeated under various circumstances. This is indeed needed. There is a good deal of conflicting evidence; and the various figures have as yet perhaps more scientific interest than practical value. The analysis of our water supply is of a twofold kind. The chemist determines the total solids, organic carbon and nitrogen, ammonia, other nitrogen, chlorine, and hardness. When the results of the analysis show either the presence of a large amount of inorganic nitrogen or of actual animal matter, the possibility of a sewage contamination has to be considered. In addition to this chemical analysis, Dr. Frankland gives bacteriological tests. In July, for instance, the Thames water yielded 3000 colonies, and the filtered water supplied at Chelsea, 59; at Southwark, 380; the Lea water unfiltered, 5400; the New River Supply, 46; East London, 134; the Kent deep well water, 12; and the Kent supply, 48. It would appear that the water from the cab-rank was as good as the Kent deep well water. For some time up till April, 1886, Professor Bischof favoured our columns with reports on the metropolitan water supply. He discontinued these reports, because he had lost confidence in the reliability of Koch's test, and he explained his views fully in a paper read before the Society of Medical Officers of Health, April 16, 1886. In the discussion of this paper Dr. Klein stated that in one instance Dr. Koch's test indicated only 5700 colonies, where another method gave 150,000; and that he had repeatedly failed to find the larger number of microphytes which he had added, notwithstanding that in this case he knew exactly what to look for. All this does not imply that tests of this kind should be abandoned as unreliable and fruitless. It would appear similarly consistent to suggest that all the money spent in filtering our water is wasted, since it is quite immaterial, considering the filthy state of many a water cistern, what quality of water we supply.

* Proc. Roy. Soc., June 18, 1885.

TORPEDOES AND WARSHIPS.

Having given, in our issue of February 11, a sketch of the progress that torpedo boat construction has already made, before leaving altogether the consideration of the character of the vessels to which the torpedoes are to be adapted, let us look a little into the evidence before us relating to the probable future type of vessels which will include torpedoes in their armament. It will then be easier to select, from the various torpedoes in the market and under experiment, those, or that one, which will best fulfil the required conditions. Weyl says, in relation to this inquiry, that if we are to attain success and solve the many problems that will be encountered in the use of the torpedo, which is only one arm more, we must employ method and perseverance. The torpedo is imperfect, and the boat itself must be improved. It is an excellent weapon, but its combination with the boat must be thoroughly studied and decidedly modified before this useful submarine engine becomes truly military.

Gougeard claims that the ideal quality of a modern fighting ship is "floatability"—that without it no ship can exist. The Russians believe they have secured this essential in the unarmoured Rinda type by numerous compartments and enormous pumping capacity. It is claimed that the pumps of these cruisers have a power of nearly 2,000,000 gallons per hour.

It will be difficult to combine all the qualities in one ship that have been demanded by M. Gougeard and Mr. White; but already very efficient ships of moderate tonnage are afloat, possessing high speed, floatability, excellent manœuvring powers, carrying large guns of great energy, their vitals reasonably protected, and equipped with secondary batteries of quick-firing guns and torpedoes. It is evident that these conditions make them valuable vessels for most any circumstances that they would be liable to meet. The armament of torpedoes should be of such a nature as to be thoroughly reliable, cheap, handy, and destructive.

To the above Herr Attlmayer would add the ram, being convinced that, in the future, as long as warships supply their own motive power, ramming will continue to be a mode of attack, and for this purpose they should receive additional bow strengthening. He is also of the opinion that future construction will be lighter, that the ships will be more quickly built, and consequently naval progress will be more rapid.

Some authorities believe that there is nothing which will compensate for invisibility, and that all other qualities should be subordinated to a concentration of torpedo power. This may obtain in coast and harbour torpedo defence, but cannot enter into the consideration of sea fighting until habitability and seaworthiness are combined with invisibility. The improbability of such an accomplishment will permit us, therefore, for the present to omit a consideration of it. When the "invisible" torpedo boats (of the 100 ft. length, for example) were designed and built they were intended for coast defence and rapid concentration on the coast. They were not intended to go to sea; hence, when this demand was made of them they failed. The results of the French manœuvres in the Mediterranean should be heeded, proving as they have the incompetency of such small craft to fight upon the open sea. They have shown the necessity for other types of efficient ships, such as armour-clads and cruisers. These failures, however, are but further incentives for greater progress. As Weyl says, we must resume our studies with a new programme, no longer limiting ourselves to "the tactics of the microbe against the giant." We must give our attention to the use of the torpedo boat in all the formations of battle as an annex of the heavier ships of the squadron. We should not sacrifice to invisibility all the qualities which make up a useful sea weapon. He believes there should be created a type seaworthy and habitable, larger than the torpedo boat which the French call "automatic," and smaller than the despatch vessels of 320 tons that proved themselves so efficient in the Mediterranean exercises. This, he considers, will be the true sea torpedo boat, and the 100 ft. type will remain near the shore devoted to the defence of the coasts for which it was designed.

Admiral Elliott thinks that speed is less essential than handiness; hence his advocacy of ships of more moderate dimensions, believing them to be better suited to the requirements of battle than the foreign first-rate cruisers. He also expresses the opinion that "strict adherence to special requirements should be the first object sought to be obtained, and that the smaller the vessel the greater is the necessity for excess of speed, as the only means of escape from capture."

Gougeard gives the following as his objection for a torpedo vessel: "Construct a veritable seagoing vessel possessing nautical qualities in the same degree as our best ships. Her principal weapon should be the torpedo. She should be so built that the artillery up to and comprising 10-in. guns, fired under probable conditions, cannot seriously damage her. Give her a speed equal, or even superior, to that which has been obtained in the trials of torpedo boats (French) Nos. 63 and 64." In other words, "ships that will have for characteristics great speed, steel deck protection and a floatability obtained by means of cells filled with buoyant material. Increase, if possible, their cellular system, and seek within the limits of the weight at your disposal, the maximum resistance to the torpedo."

Admiral Brown de Coulston, in his testimony before the French Budget Commission, stated that "he was an advocate of a cruiser of medium tonnage, well armed and protected."

An examination of the details of vessels designed, built and building in all the countries making any attempts to progress in this art, discloses the application of torpedoes to vessels of all classes and dimensions, from the 60 ft. second-class torpedo boat to the armoured barbette ship of 10,000 tons. In addition to the boats being built by firms making that a speciality, we find all naval constructors giving particular attention to a ship of average dimensions to meet the requirements of torpedo warfare. The development has already carried us from second-class torpedo-boats up through first-class torpedo boats, torpedo despatch vessels, torpedo gunboats, gun and torpedo-boats, to torpedo cruisers. Furthermore, the votes of credit have devoted no small share of their totals to this purpose. The Spanish Government intends to devote some seven millions sterling, all of which will probably be spent on vessels not exceeding 5000 tons displacement. France has indorsed her estimate of torpedo warfare by a recent vote of 28,000,000 francs, in which we find no provision for ships exceeding 4200 tons, but great prominence given to torpedo vessels.

For the employment of torpedoes all evidence points to cruisers of as small displacement as will accommodate the motive power and the arms to be carried. To-day the most popular weapon is the torpedo, and it is for the best application of that instrument that designers are so energetically competing.

We have now arrived at those conditions which, for a reasonable time at least, will govern in seagoing vessels the character of the torpedo that

should be employed, the instrument for, and method of, its discharge, and the amount of space that can be allotted for their carriage, supply, and use.

The qualities that such a ship should combine are high speed, great manœuvring power, steel deck, protection of the vitals, floatability, and such distribution of the protecting weights as will give the conning tower and torpedo equipment as great security as possible. There should be an armament of quick-firing and small calibre high velocity guns, but the torpedo should be its principal arm. If experiments prove that the ram bow is not too great an impediment to high speed, strength and form should be provided to give this additional power.

NOTES.

Spanish Iron Ore.

The exports of iron ore from Bilbao last year amounted to 3,160,047 tons, as compared with 3,295,982 tons in 1885, and 3,155,432 tons in 1884. In these totals the shipments to Great Britain figured for 2,151,137 tons in 1886; 2,050,185 tons in 1885; and 1,990,993 tons in 1884. The Low Countries took 534,687 tons in 1886, as compared with 653,919 tons in 1885; and 601,414 tons in 1884, while France took 332,103 tons in 1886, as compared with 491,085 tons in 1885, and 458,225 tons in 1884. It is noticeable that a commencement has been made with deliveries to the United States, 42,337 tons having been forwarded to the great Transatlantic Republic in 1886, as compared with 7304 tons in 1885, and 2259 tons in 1884. It will be observed that the shipments to Great Britain are increasing rather than otherwise, and that they amounted in 1886 to 68.04 per cent. of the whole exports of the year. The proportion of the exports to Holland last year was 16.60 per cent., and that of those to France, 10.52 per cent., leaving only 4.84 per cent. to represent the shipments in all other directions.

The Copperas Waste.

The amount of sulphate of iron wasted at wire works is very great, and reaches large proportions in some other iron industries. The manager of a large wire works in Pennsylvania, United States, stated that 17 tons of sulphate of iron were discharged into the river daily at his establishment. This waste is obviated in some other works by running this pickling liquor into vats, where it is warmed by steam, and enough waste wire added to saturate the solution with iron, when the liquid is drawn to shallow tanks, and in the process of cooling the copperas crystals form upon the sides of the tank and on sticks, which are placed there to form nuclei for the crystallisation. This copperas contains too much impurity for the market, so it is converted into Venetian red paint, by mixing it with lime and roasting in a muffler furnace and then after pulverised gypsum has been added, the whole is reduced to a fine powder. The product sells for 1½ cents per pound, and is said to form a profitable disposition of what is otherwise a waste in manufacturing, and a detriment to waters receiving the discharge.

Steamers in Siberia.

At a recent meeting of the Russian Mercantile Marine Society, M. Igoumnoff read an interesting paper on the present condition of shipping on the Siberian rivers. The first steamer in Siberia made its appearance in 1842, but it was not until 1845 that one of any size began to run; the pioneer vessel being the Osnova or Basis, having machinery of 60 horse-power. In 1854 the total number of steamers in Siberia was five, in 1860 there were ten, in 1865 the number had increased to 23, in 1876 to 43, and by the end of last autumn to 58. This is not a large number for a territory larger than all Europe or Canada, and which Russia has held for 300 years. Besides steamers there are 200 barges, ranging in length from 200 ft. and 250 ft., and 100 from 150 ft. to 200 ft. long. The most powerful steamer on the Siberian rivers is one of 160 horse-power. The centre of the traffic is Tiumin, through which goods to the extent of 4½ million poods, or 70,000 tons, pass every year. It is the drawback of the Siberian rivers that they nearly all flow to the Arctic region, and although some years ago English navigators penetrated to the Obi and Yenesei, the perils of the passage through the Kara Sea nipped the enterprise in the bud. At present there is little inclination to increase the steamers in Siberia, as its raw produce cannot find a ready market in Russia, owing to the competition in the corn, hide, and tallow trade. About 8000 peasants migrate thither every year, and the extension of the railway system is opening up the country, but none the less its progress is very slow.

The World's Silver.

The production of silver throughout the world during the ten years ending with 1886 inclusive, is estimated at 193,050,000*l.* In this total 1877 figured for 16,500,000*l.*; 1878 for 18,100,000*l.*; 1879 for 17,900,000*l.*; 1880 for 17,800,000*l.*; 1881 for 18,600,000*l.*; 1882 for 19,710,000*l.*; 1883 for 20,350,000*l.*; 1884 for 20,550,000*l.*; 1885 for 21,420,000*l.*; and 1886 for 22,120,000*l.* It will be seen that the production of 1886 was larger than that of any one of the previous nine years, and that the silver yield of the world is, if anything, gradually increasing. The United States form the most important silver-producing region, having yielded 8,000,000*l.* in 1877; 9,000,000*l.* in 1878; 8,200,000*l.* in 1879; 7,850,000*l.* in 1880; 8,600,000*l.* in 1881; 9,360,000*l.* in 1882; 9,650,000*l.* in 1883; 9,750,000*l.* in 1884; 10,320,000*l.* in 1885; and 10,800,000*l.* in 1886. Mexico and other South American countries also produce a good deal of silver, having yielded 6,500,000*l.* in 1877; 6,900,000*l.* in 1878; 7,300,000*l.* in 1879; 7,450,000*l.* in 1880; 7,500,000*l.* in 1881; 7,650,000*l.* in 1882; 7,800,000*l.* in 1883; 7,900,000*l.* in 1884; 8,200,000*l.* in 1885; and 8,420,000*l.* in 1886. The balance of the world's silver is furnished by Europe, which will be seen to have yielded only a comparatively small amount.

Electrical Transmission by Hot Air.

M. Blondlot has communicated a paper to the French Academy of Sciences for the transmission of electricity of low tension by means of hot air. In 1853 M. Edmond Becquerel found that heated gases allowed electricity to pass even when only one battery was the source. M. Blondlot has verified this result. The discharge took place in an inverted bell-shaped chamber heated by a Perrot furnace. Platinum electrodes 3 centimetres in diameter, were used and properly insulated. It is after red heat is reached that the current commences to pass. The current of hot air from an incandescent body allows the current of a single cell to pass. M. Blondlot finds the current to pass even though the electromotive force is $\frac{1}{1000}$ volt. He also finds that the resistance of the heated air is not a true resistance of the kind found in solid and liquid conductors, but depends on the electromotive force and the intensity of the current. M. Blondlot thinks it probable that the current is transmitted by convection, a term used by Faraday, to signify the transport of electricity by particles of air charging themselves on the electrodes, and discharging again. Convection, he thinks, may be impossible because of the adherence of the air and platinum, but possible when this adhesion is destroyed by heat.

New Railway Schemes in Norway.

Although no definite decision has been, or is perhaps for some little time likely to be arrived at, as to the projected railway from Bergen to Christiania, the time is not far distant, when the two largest towns in Norway will be connected by a railway line. Whatever route may be adopted, and there are several on the tapis, this new line will offer very considerable engineering difficulties, and it is only within the last few years that the scheme has been looked upon as at all practicable. The latest plan—the Aurland line—is said to possess several advantages over its predecessors, but still it will for a distance of 20 kilometres, have to run at a height of 3000 ft. above the sea level. Its highest point—Gjeitserryggen—is about 1130 metres, or some 3600 ft. above the level of the sea, but this is 170 metres lower than the highest point of the Rundals scheme. This latter line would also necessitate the railway running at a height of 3000 ft. or more, for the much longer distance of 70 kilometres. Among the advantages of the lower line are less risk for snowdrifts and less frequent fogs, and the supply of water appears to be more abundant. Also as regards the inhabitants of the surrounding country, the Aurland's line is more favourably positioned than its rivals. The longest distance between the "Salters"—the mountain pastures where the cattle are kept during the summer time—is only 8 kilometres, while it, on the other line, amounts to 40 to 50 kilometres, and the "Salter" time is only six weeks on the latter against ten to sixteen weeks on the former. The soil is also more tractable on the Aurland line; there are, however, a couple of tunnels, through the Klovfjeld, a length of 3.5 kilometres, and through the Grundfjeld, a length of 1.5 kilometre.

Diamond Mining at Kimberley.

More than two miles of driving have now been completed in the claims of De Beer's Mining Company in the neighbourhood of Kimberley, Griqualand West. The driving includes 10,330 ft. of tunnelling, besides 1150 ft. of small shafts, and passes under 1100 ft. of large shafts. The underground works were commenced in April, 1885, and since that date upwards of 300,000 loads of rich blue ground have been hauled by an inclined shaft. At the present time the daily output of blue at this shaft amounts to 1800 to 1900 loads. The hauling has thus far been effected by a 16 horse-power engine, but another engine of 40 horse-power is now being erected, and will be shortly got to work. The new engine will haul 2000 to 3000 loads of blue per day with ease. Nearly 2,000,000 loads of blue have been opened out and are ready to be worked, while about an equal quantity is being opened out at lower levels, so that even if it raises 2000 loads of blue per day the company has a clear six years before it. These calculations, it should be added, are based upon an area of 200 claims now being worked underground, but the present ownership of the company comprises upwards of 300 claims. The drainage of the mine is effected by a pair of horizontal geared pumps driven by an engine of 25 horse-power, and capable of lifting 15,000 gallons of water per hour. In the twelve months ending March 31, 1886, the company hauled altogether 391,747 loads of blue, and with this output it was enabled to pay a dividend of 12 per cent. upon a capital of 1,045,120*l.*, although diamonds averaged during the year the unusually low price of 16s. 4½d. per carat.

The Anglo-American Brush Company.

The annual report of the Brush Electric Light Corporation, Limited, shows that electric lighting is still far from being a lucrative business. The gross profit of the year amounts to 14,431*l.*, but when all standing charges and expenses are deducted from this, only 618*l.* are left as a balance. During the past year the International Electric Light Company (formerly the Anglo-Austrian Brush Electric Light Company) has been taken over together with the business of Messrs. Kremenezky, Mayer, and Co., of Vienna, the electric installation at the town of Temesvar and the existing contract with the municipality, the terms of purchase being one 5*l.* fully paid share for every twenty 4*l.* paid shares of the International Company. The Brush and Lane-Fox licenses formerly held by the Hammond Company in thirteen counties in England, have been repurchased, so that now the parent Brush Company has regained its privileges over the entire country with the exception of the towns of Eastbourne, Hastings, and Dublin. In view of impending litigation the Lane-Fox patents have again gained importance, and the Board have acquired those relating to distribution and incandescent lamps, by the liquidation of certain charges upon them—in one case by a small cash payment, and in another by 1348 fully paid-up shares. The Corporation is not free of litigation; many of the leading manufacturers have acknowledged their rights in the matter of compound winding of dynamos, but two or three firms hold out, and are being proceeded against. On the other hand, the Edison and Swan Company have brought an action against a user of a Victoria lamp, and the Corporation are defending the action. By way of reprisal they have caused an action to be entered against the Edison and Swan Company for infringement of the Lane-Fox patents. It is interesting to learn from the report that there are no less than fifty manufacturing and electric light firms in the United Kingdom.

Electric Lighting Act Amendment Bill.

Last year three Bills for the amendment of the Electric Lighting Act were submitted to the House of Lords by Lord Rayleigh, Lord Bury, and the Government respectively. They were all referred to a Select Committee, who took evidence, and finally agreed, although not unanimously, to a Bill by which the term of compulsory sale to the local authority was extended from twenty-one to forty-two years. The Bill was practically adopted by the House of Lords, but the resignation of the Government prevented all further progress. This session Lord Thurlow has introduced a Bill in which the period is extended to forty-two years,

and in addition it is provided that the local authority shall pay "the then market value of the goodwill of the business of the undertaking, and of all lands, buildings, works, materials, and plant. . . . due regard being had to the nature and then condition of such buildings, works, and plant, and to the state of repair thereof, and to the suitability of the same to the purposes of the undertaking. . . . but without any addition in respect of compulsory purchase." It remains to be seen whether the Legislature, which meted out such hard terms to the electric light interests in 1882, will be now willing to go to the length of doubling the term of their monopoly, and then paying them for their goodwill. It is quite certain that if we are ever to have any public electric lighting the period assigned to the undertakers must be increased very considerably, and no one can suppose that a speculative enterprise of this kind can be safely entered into for a shorter term than forty-two years. But the purchase of the goodwill raises many questions which cannot be dismissed by saying that the price shall be settled by arbitration. In the first place, if the companies are paid for their plant and also for their goodwill, what equivalent are they going to give for having a district assigned to them in which they will be guarded from competition, and be permitted to lay their mains in the public streets without rent? Such a privilege is worth paying for, but we cannot see that the Bill acknowledges this fact. The company which is situated in a place where the electric light has been well received, and where progress has been rapid and easy, will have spent but little in creating a goodwill which will be very valuable, while a company which has had to educate the public to the appreciation of its light, may have spent a great deal in creating a goodwill which will be estimated at a small figure. We fear that the clause relating to goodwill will not get safely through the House of Commons.

The New Employers' Liability Act.

The Employers' Liability Act of 1880 will continue in force until the end of this year, and it is expected it will in the mean time be re-enacted in a way far more favourable to the workman than at present, as a Committee which sat last session, under the presidency of Lord Brassey, reported "that the operation of the Act of 1880 has been attended with no hardship to employers, whilst it has been of great benefit to workmen, and it is desirable that the Act should, with certain amendments, be renewed and made permanent." Starting from this basis the Committee recommended that the practice of contracting out of the Act should be stopped, except in such cases where the employer should contribute to an insurance fund for the benefit of the workman or against every accident arising in his employment. In such case the employer's contribution must bear a full proportion to the contributions of the workmen in order that the fund should be able to provide the amounts recoverable under the Act, and if it should be able to do this, the employer is to be liable to make up the deficiency. As to the servants of sub-contractors the principal employer is still to be liable in respect of injuries sustained by such workmen of a contractor or sub-contractor by reason of any defect in the condition of the ways, works, machinery, or plant, if such be the property of or furnished by the employer, and if such defect arose, or had not been discovered or remedied owing to the negligence of the employer or of some person entrusted by him with the duty of seeing that works or plant was in a proper condition. Provision is to be made to reserve the right of action of the workman against his immediate employer, and of the principal employer against the contractor. Another and more important proposal, at least in the engineering trades, is to extend the compensation to the result of negligence in a fellow-servant of a superior grade, whether he be a foreman or not. The result will be that the employer will become liable for the negligence of a bricklayer towards his assistant, of a smith towards his striker, of a mechanic towards a labourer, and so on. The next point refers to an extension of the time of giving notice of an injury, and is followed by others raising the maximum damages to be awarded to 150*l.*, and providing for actions to be tried before a special jury at the discretion of the judge. The term "workman" is to be enlarged to include seamen, omnibus and tramway servants, and all under a contract of service, expressed or implied; also manual and domestic servants, and all servants other than those engaged in manual labour. It will be seen that if an Act is passed on those lines it will greatly increase the liability of employers, and will add to the expenses of production. Those who wish fuller information on the subject will find it in a very lucid and well-considered pamphlet written by Mr. J. Leslie Field, Middle Temple and Lincoln's Inn, and published by John Heywood, of London and Manchester.

NOTES FROM THE UNITED STATES.

Philadelphia, February 11.

Consumers of steel in the interior have instructed their brokers at tidewater markets to terminate for the present all negotiations for additional supplies, unless they can be had at prices named, which are 30 dols. for rail blooms and 32.50 dols. for nail slabs. Bessemer pig is wanted at 21 dols. to 21.50 dols., and spiegeleisen at 28 dols. Old rails have weakened 50 cents to 1 dol., and are quoted to-day at 24.50 dols. to 25 dols.; 20,000 tons are wanted at 24 dols. to 24.25 dols. The heavy consumers throughout the interior have moderate supplies on hand, and are not very urgent about additional stocks, excepting at the prices which prevailed a month ago. All kinds of foreign material will sell here without trouble, provided prices meet buyers' views. Otherwise business will be delayed for a few weeks. The steel railmakers have taken very little new business for three weeks. Most of it consists of small lots running from 500 tons to 2000 tons, for which 39 dols., 39.50 dols., and 40 dols. are to be paid, and delivery to be made between June and August. Inquiries are on the market to-day for large supplies that would aggregate 70,000 or 80,000 tons for September and October delivery, but buyers will not pay present prices. The high quotations in steel rails are the result of the very heavy demand, which put a million and a quarter tons on the books of the makers. As the producing capacity is now sold up until autumn, there is nothing to do but to place orders for later delivery, and that the large builders are unwilling to do at present, excepting at prices that prevailed two months ago, namely, 34 dols. to 35 dols. Makers will not accept such business, as material and labour may advance, and strikes may occur. As soon as the probabilities for the summer and autumn can be discounted a large amount of business will be placed. Buyers expect to secure autumn deliveries at 36 dols. to 37 dols., although makers deny that any such figures will be accepted under any circumstances. Comparatively little business has been done during the week in foreign rails, although several brokers are expecting to close contracts which will put up about as much as 25,000 tons to 40,000 tons for South-Western or Pacific coast delivery. The Huntingdon and Gould systems are in need of a great many rails, and are only partially provided for. Whether they will wait on American mills or buy abroad is a matter which their brokers are not able to speak of definitely. The commercial outlook continues healthy and encouraging. A few strikes are in progress, but they will be disposed of in a few days. The labour question will occupy less attention this year than last, and no general strike for eight hours is anticipated. The crude iron production is all absorbed in orders placed within the past two months, and very few companies are seeking new business for summer delivery. Foundry iron ranges from 22 dols. to 23 dols. Mill iron averages 19 dols. A few inquiries are made from day to day for Middlesborough pig. The plate and structural mills have a very large amount of business coming in.

Civil and Mechanical Engineers' Society.—We learn that the members of this Society will visit the new drainage and ventilation works at the Houses of Parliament on Saturday, the 26th inst., assembling at the entrance to the House of Commons at 2 p.m.

Gold Quartz Stamp Mill.—Yesterday Messrs. Appleby Brothers, Limited, showed at their works at East Greenwich, a fine 15-head gold quartz stamp mill, which they have just completed for the Livingstone (Queensland) Gold Mining Company. Each head weighs 750 lb. and makes seventy drops a minute under the action of a two-armed wiper cam. The dies, stamp heads, and lifters, are all of forged steel; the frame is of wrought iron. The output of the machine will be 36 tons of quartz per day, and as the rock contains 3½ oz. of free gold to the ton, a good return is anticipated from the mine.

Gas Firing.—We have received from Mr. Bernard Dawson, of 110, Cannon-street, E.C., an illustrated volume showing the application of the Wilson gas producer to many kinds of manufacturing operations, such as iron melting, ladle heating, mould and core drying, brass melting, annealing, forging, welding, brick burning, blast heating, retort firing, and many others. The book is most liberally furnished with engravings, both plain and coloured, and forms a capital guide to the capabilities and advantages of gas firing, apart from any particular system. We note that the Wilson producer is used by the London and North-Western Railway Company, at Crewe, Earlstown, and Wolverton.

RAILWAY COMPANIES AS MANUFACTURERS.

To the Editor of Engineering.

Sir,—The above subject is one which must sooner or later receive the attention of our Government if the trade and commerce hitherto carried on so extensively by private establishments is to continue in the future as in the past, the chief source of our national prosperity. It is generally understood to be a railway company's peculiar function, and that which will reflect most favourably upon its own financial condition, to foster and encourage by every means in its power private industries and enterprises upon its own and adjacent systems.

Such used to be the attitude of railway companies in the early days of their existence, and was it not in consequence of this encouragement that manufactories were established, not in close proximity to harbours or with private docks from which their goods could be shipped direct to their foreign or colonial destinations, but inland on the railway system of some company from whom they formerly received work, and who were amply repaid for such in the carriage of raw material from one manufacturer to another, and of the finished goods to the seaport or other destination? There is almost no industry of importance in which the people of this country are engaged which cannot be shown to be directly or indirectly engaged in the production of some power or appliance to facilitate railway companies in their legitimate carrying trade. Starting at the lowest round of the ladder, why, it may be asked, should the coal which is needed to generate steam in their locomotive and stationary engines not be taken from its bed in the earth by the railway company? A traveller must have rest after his fatiguing journey by rail; railway companies must therefore be proprietors of hotels so as to be able to provide the necessary sleeping accommodation. And so on we might go *ad infinitum*, until we might not unnaturally expect to find a railway company engaged in the art of shipbuilding, and turning out large ocean-going steamers to take passengers who perchance happened to avail themselves of their system from London to Southampton over the seas to Africa, India, or Australia.

The question is, where and when is this manufacturing craze on the part of railway directors to gratify the ambition and establish the importance of their officials, to end? Most sensible people are of opinion that this system should never have been allowed to obtain a footing in this country at all, as it is entirely at variance with the first principles of free trade and manifestly unfair, that a railway company which has a permanent monopoly in the main source of its revenue should be permitted to build its own rolling stock, instead of purchasing it from private manufacturers in the open and consequently cheapest market. In a railway workshop where repair and new work are carried on simultaneously and contiguously it is utterly impossible to keep separate and correct accounts of the value of the time and material expended on each separate item, even supposing there were no temptation to let this difficulty afford the means of "working the oracle." There are a few important primary principles which if violated by those privately engaged in trade and commerce never fail to result in disaster and eventually in ruin. In the first place it is generally acknowledged that competition is the best, or rather the only means of keeping down cost in production, and we know that in a railway shop there is an entire absence of competition.

Thorough division of labour is considered to be essential to rapidity and economy in construction, and in violation of this principle we have on our railways superintendents whose personal duty it is to look after the rolling stock scattered over the entire lengths of their railway systems, extending as they do in some cases to over 1000 miles, and who are, at the same time, expected to supervise in the railway workshops the repair of these numerous vehicles and the construction of new locomotives, carriages, wagons, &c. It is further necessary that managers and foremen should have a personal financial interest in the success of the manufactory in which they are employed to produce the best results, while in a railway shop this, even if attempted, is impracticable where repairs and new work are in progress side by side. When a Bill for the construction of a new railway is being considered by Parliament, it would not further the passage of the measure were an enthusiastic advocate of the Bill to inform the House that the proposed railway would be certain to prove a splendid investment for its shareholders. What the representatives of the people would have to consider in such a case would be whether the proposed railway would be a benefit to the nation as a whole, and if in their opinion it would not prove such, then their clear duty would be to throw out the Bill at once. For similar reasons we find the House of Commons has from time to time rejected such a proposal as the famous "Channel Tunnel Railway Bill." Acting upon the same principle, our legislators in their wisdom have seen fit to limit the maximum charges that can be exacted by railway companies from those who travel over their systems, and Parliament has also wisely prohibited railway companies from manufacturing rolling stock for other railway companies, as such operations would interfere unfairly with private enterprise. Whatever, therefore, the railway shareholders and their servants the officials may think on this subject, the nation undoubtedly considers railway companies only in the capacity of servants to the public.

What I understand private manufacturers desire in this matter is that railway workshops should be employed exclusively in the repair and upkeep of their present rolling stock, and that in times like these they should order their new plant from private manufacturers, thus affording work (not necessarily profitable work) to enable such industries to keep their men together and their machinery in motion. The railway companies would thus

reap the double advantage of purchasing their plant at or below cost price, and of keeping alive in their midst industries from which they would derive much substantial advantage in good times.

From reports just published we find that the value of locomotives exported from Germany during 1886 was about 250,000*l.*, as compared with locomotives to the value of over 400,000*l.* shipped from the Clyde alone, and if we compare the annual output or capacity of German with Scotch locomotive factories they will be found to be in the ratio of three to one; thus showing that the Germans have their locomotives manufactured in their private workshops, which are thus kept alive, and in a state of preparation for competing successfully with all comers for the supply of locomotives when such fields as China and Japan are thrown open to the influence of western civilisation. It is said that "opposition is the life of trade," and so it is; but unless private manufacturers obtain a "fair field" they must inevitably cease to exist. Shareowners in their own interest should see that their directors adopt more wise and prudent measures of economy than those now becoming so fashionable, and our Government, for the welfare of the nation as a whole, should require that free trade principles be adopted in our internal commercial and manufacturing relationships as well as in our international undertakings.

I am, Sir, yours truly,

February 22, 1887. FAIR PLAY.

ENGLISH *v.* AMERICAN LOCOMOTIVES.

TO THE EDITOR OF ENGINEERING.

SIR,—I notice an inadvertent and obvious error of language in my letter of the 15th inst. on this subject, which, in justice to Mr. Smith, you will, I trust, allow me to correct. I therein say: "It is true that Mr. Smith, by *squaring* the number of pounds of fuel per indicated horse-power per hour consumed," &c. I ought to have stated the case thus:

It is true that Mr. Smith, by increasing—as the *square* of 56.6 is to the square of 43 3—the number of pounds of fuel per indicated horse-power per hour consumed by the "Gladstone" engine at 43.3 miles per hour, converts 2.05 lb. (the "Gladstone" consumption at 43.3 miles per hour) into 3.48 lb. at 56.6 miles per hour, on the assumption, as he says, and perhaps—as far as it goes—a true assumption, "that the *resistance* increases as the square of the speed;" one of the most free and easy, &c.

The final query in the paragraph ought then to have run thus: Why did he not at once increase 2.05 as the *cube* of 56.6 is to the cube of 43.3 and so have got a still higher figure for comparison?

With these verbal changes the substance of my letter of the 15th inst. stands unaltered.

I am, Sir, your obedient servant,

ROBERT H. BURNETT.

Victoria-street, Westminster, Feb. 19, 1887.

TO THE EDITOR OF ENGINEERING.

SIR,—To correct the erroneous impression likely to be made by "Stoker's" letter under the above caption, and which appeared in your issue of December 31, allow me to state that the grate area of the engines in question is 29.8 square feet, the inside measurement of firebox being $102\frac{3}{8}$ in. by $41\frac{7}{8}$ in., and therefore considerably larger than assumed by your correspondent, and amply sufficient to furnish steam for the 20 in. by 24 in. cylinders.

The result of their *large grate area* is that fine coal screenings can satisfactorily be burnt, and as stated by Mr. Charles Slackvill, who placed this class of engine upon the Norfolk and Western Railroad, and for which road the engines in question are building, the monthly saving in value of fuel per engine, by so doing, amounted to about 100 dols., or nearly 21*l.*, these figures being based on an assumed monthly engine mileage of 3000 miles, and ordinary "run of mine" coal at 1.30 dols. and screenings at 0.50 dol. per ton of 2000 lb.

In describing the engines as "track crushers," your correspondent is also "at sea," the maximum load per axle not exceeding 24,550 lb. in working order.

For what he terms "track crushers," "Stoker" need not look beyond England for extreme examples. He, like many other stokers, appears to have a good deal yet to learn.

Yours respectfully,

February 7, 1887. ANGLO-AMERICAN.

TO THE EDITOR OF ENGINEERING.

SIR,—As a constant reader of your paper, I have been struck by one or two phases which the controversy on this subject has assumed at the hands of your American correspondents, to one of which phases you will perhaps permit me to allude. Mr. F. C. Smith's letter in your issue of the 11th inst., which has already received some notice from correspondents, induces me to address you.

Mr. Smith, writing from the American point of view, complains of engine "No. 169" on the Philadelphia and Reading Railroad having been taken as a specimen of the American type and put in comparison with an English engine, because of its being, as he says, a "Wootten" engine, and not a representative of the American type at all. Mr. Burnett has already commented upon Mr. Smith's "summary disposal" in the way of engine "169," but there is one feature of the case to which Mr. Burnett does not refer. It is, that up to the date of Mr. Smith's letter, or ten months after the comparison to which it refers was published, not one syllable of objection was advanced by the many writers on the American side of the question against taking engine "169" as an American type of locomotive and putting its performance in comparison with that of the English engine "Gladstone." And here, perhaps, I may be permitted to say, by way of parenthesis, that the validity of Mr. Smith's plea for excepting that engine from comparison with the English engine, on the ground, apparently, that the former has 38.64 square feet of grate area as against 20.65 in the case of the latter, is not very clear, seeing that as regards tractive power and weight, the two engines are practically identical, while the heating surfaces are not far different. But to return to the question. After what other American authorities have written on the subject, Mr. Smith's repudiation of "No. 169" at this time of day is startling, as it is novel.

Mr. John Fernie, of Philadelphia, who was the first on that side of the Atlantic to take up the American cause, never suggested any repudiation of the engine. On the contrary, in commenting on Mr. Burnett's comparison, he wrote in the highest terms of it and its performance. In his letter in ENGINEERING of July 2 last, he said of it: "A machine in which there is not a pound's weight of material more than is required, not a cent's worth more cost than is necessary; there is no other engine which has such steaming qualities, or can take such heavy loads, and this engine is a racer too, as Mr. Burnett describes; it coming thundering along at more than 70 miles an hour with the brave boys strapped on, coolly taking their diagrams. We hold our breath, and say, on what English engine would you like to do this? When, most astonishing, Mr. Burnett trots out a Brighton engine, and with his pencil and paper and a few figures runs the American engine off the road." No attempt here, on Mr. Fernie's part, to repudiate engine "No. 169."

But let me quote another witness who may be assumed to know something about the question; one not "prejudiced," as some persons say writers on this side the Atlantic are, against American locomotive practice (of course our American friends are absolutely free of prejudice!) and one likely, therefore, to have put the case as fairly for the American cause as the facts appeared to it to permit. I mean the *National Car Builder* of New York. In a good-natured and somewhat amusing, although extremely superficial, "leader," in its issue of October last, commenting on the articles and correspondence in your paper—a leader which is perhaps worth reading merely as an example of skill in fencing a question, and in retiring under cover of smoke from an unsuccessful assault on an opponent's position—the *National Car Builder* says: "A correspondent having mentioned a recorded performance of a locomotive belonging to the Philadelphia and Reading Railroad (engine "169," Jersey Central Division) as being worthy of any country or any kind of engine, the valiant Burnett comes out with an array of figures backed by a Stroudley locomotive, and proves to the satisfaction of himself and friends that the Philadelphia and Reading engine was a wretched machine and the performance unworthy of mention." Here, again, not one word of repudiation of engine "No. 169." On the contrary, the *National Car Builder* speaks of its performance "as worthy of any country or any kind of engine," and finds no way out of the difficulty but in treating with scorn the unfavourable comparison of its performance with that of the "Gladstone" engine which Mr. Burnett's figures "prove."

Now, however, we have Mr. Smith's testimony for it, and Mr. Smith, from his "extended experience," as he himself says, "with American engines, as machinist, locomotive engineer, draughtsman, and division M.M., or general foreman," is no mean authority—I say we have now Mr. Smith's testimony for it, on which Mr. Burnett has already commented, that "No. 169" is only a "Wootten" engine, designed "regardless of economy," and not "a representative of the American type at all;" this very engine which Mr. Fernie said "had not a pound's weight of material more than is required," and "a racer too," &c. Moreover, we are told by Mr. Smith, that it came out second best in competition with an "ordinary typical American engine" of the New York and Hartford Railway, and, in short, that it is not fit to be put in competition with "a typical English engine." In effect, that Mr. Burnett's unfavourable comparison of it with the English engine "Gladstone" was justified, and that the conclusion to be drawn from that comparison, as pithily expressed—although sarcastically meant—by the *National Car Builder*, is true, viz., that engine "169" is a "wretched machine, and the performance unworthy of mention."

In the face of such diametrically opposite, and mutually destructive opinions by American authorities on so simple an issue, "we hold"—to use Mr. Fernie's language—"our breath, and say," when doctors differ, who shall agree? When such great American authorities as Mr. J. Fernie, of Philadelphia, the *National Car Builder*, of New York, and Mr. F. A. Smith, of Delaware, are seen to differ so materially on the question of American locomotive performance and practice, what reliance, one naturally asks, can be put on opinions expressed on this subject by American correspondents in general?

Yours truly,

MECHANICUS.

Parliament-street, Westminster, Feb. 22, 1887.

CHEMISTRY OF THE BASIC PROCESS.

TO THE EDITOR OF ENGINEERING.

SIR,—The importance of utilisation of the slags from the Thomas-Gilchrist process cannot be overrated in this age of iron, as by this process not only is iron of inferior quality transformed into a valuable metal, but in the resulting slags phosphorus is found, which may be in proper form returned to the soil.

This interesting subject is familiar to me, having been born in an agricultural country (Poland), where I spent the best part of my life among ironmakers. From the time that I found the manufacture of iron was closely connected with the culture of the soil, the farmers and ironworkers stood before my mind as twins, happy or unhappy, but together. Besides this recollection of the past, I have lately devoted a great deal of time to the investigation of basic slags, collected from Middlesbrough and other places, and this may serve as an apology for the present communication.

Recently, the article entitled "Chemistry of the Basic Steel Process," attracted my attention, and reading there the words "with this side of the question, however, the chemists must be left to deal," I beg to offer you my small contribution in the form of the inclosed "Remarks upon Basic Steel Process."

This is not exactly the expression which I should prefer to use had Herr Hilgenstock, of Hörde, made in his paper any reference to the quantity of the air fixed in Thomas's converter, as that is the most important reagent upon which the chemistry of the basic steel process ought to be based. That remark is made because, not only must the composition of the slags, which, from other influences, may vary within broad limits, but especially because the value of the resulting metal must depend upon that quantity of the air. Such an omission is the more surprising when it is already known that even the mode of supplying air to the converter is not an indifferent condition.

The very fact of making steel from pig iron indicates that the dephosphorisation of iron must be a reducing but not an oxidising process. Such a character is clearly manifested by the escaping gases, which are combustible, and burn outside the converter. It is also indicated, though imperfectly, by the slags when they contain iron, manganese in metallic state, or only partially oxidised, and when amongst them such a product as sulphide of lime may be found frequently and in a measurable quantity.

Under such circumstances the question arises: How the highest oxide of phosphorus P_2O^5, or the anhydrous phosphoric acid can be produced and be made to appear as phosphate of any kind in a properly conducted converter?

The reply to this query is based upon direct experiments, which have been already given by the Boblique reaction (Enquête sur les Engrais: Rapport, p. 277, Imp. Impérial, 1866). This shows that 60 per cent. of iron ores smelted in a blast furnace with 100 parts of coprolites, containing about 50 per cent. of tri-basic phosphate of lime (P_2O^5, 3 CaO), gives a sufficient quantity of metallic iron to reduce integrally the phosphoric acid, P_2O^5, contained in that phosphate. The course of reduction is, according to the following equation:

$$P_2O^5, 3\,CaO + 5\,Fe + 5\,C = P_2Fe^5 + 5\,CO + 3\,CaO,$$

as is visible from the resulting product. This contains the pentaphosphide of iron, P_2Fe^5, in a crystalline form which distinctly proves a total reduction of phosphori acid; the oxygen from which is taken by the metallic iron in presence of carbon and of lime, although the lime is there, as an energetic agent, as recently formed from the phosphate.

This reaction is more remarkable, because the carbon alone has not such an action upon the same phosphate, when it is one of the resulting products in the ordinary process of extracting the phosphorus from the mono-phosphate of lime, according to the following equation:

$$3\,(P_2O^5, CaO) + 10\,C = 10\,CO + P_2O^5, 3\,CaO + 2\,P_2.$$

The excess of metallic iron, the temperature, as well as the presence of carbon, or the chief conditions of the reaction, are practically equal (if not superior) in Thomas's converter to those in the Boblique furnace, in which the anhydrous phosphoric acid, P_2O^5, cannot exist. Then its combination in any form of phosphate stands as a matter of impossibility.

It is also well known that this acid will volatilise at a red heat, which is a much lower temperature than that of melted iron. But supposing such an acid to be present in the converter, in such a case the addition of lime would not be manifested as a practical necessity, because the heavy metallic oxides, there existing from the excess of the blast, are a much more energetical basis for the removal of phosphoric acid than the lime; as is manifested by the well-known difficulty of separating the iron from phosphoric acid experienced in the analyses of natural phosphates, and of similar materials. The reference to P. Thenard's works may be also useful here as showing that the phosphoric acid in the soil is only known as combined with iron or with alumina.

However, it must be observed that the destruction, or the absence of phosphoric acid in the converter, does not exclude many other ways by which the phosphorus can pass from the metal into the slags, whether mechanically, chemically, or in both ways combined.

The mechanical action, which is the oldest agent of the puddler and the blacksmith, cannot be disregarded in the converter, because it is beyond doubt that all infusible phosphides existing in pig iron, or formed in the process, can be separated mechanically by a powerful current of gases, and in consequence of their specific gravity, which is smaller than that of molten metal. The direction and intensity of such currents, the form, the volume, the quantity, as well as the physical state of the metallic liquid mass, are all important conditions, being capable of facilitating or of obstructing the mechanical separation of impurities; but without this separation a chemical reaction would be also purposeless. A certain amount of lime or of other infusible material is capable of increasing the volume of the floating mass, and it is a sensible and efficient mode of separating mechanically a comparatively small portion of phosphorus and other impurities from melted iron.

The importance of this is also manifested by the discussion referring to the form and capacity of Bessemer converters carried out recently at the London meeting of the Iron and Steel Institute. From the mechanical point of view the basic steel process may be divided into two distinct periods, viz.:

A. The period of mixing or stirring the mass, when the gaseous matter is originated within the molten metal, causing its motion either in a vertical or horizontal direction. This is the period of slag formation, in consequence

of the contact of particles, which act one upon another according to their respective affinities.

B. The period called "after blow," when the formation of gaseous matter ceases, and the metallic liquid is only under the action of air supplied from below in a vertical direction. Then the pressure of the air in the metal helps its contraction, but owing to the equality of pressure on the horizontal plane, it has no penetrating power, so there is no reason for the movement in that direction, excepting, when the particles of the slag, previously formed, join the vertical currents of the air. This is not stirring, but, if well divided throughout the mass of liquid, it acts in the manner of a brush, helping a separation of the slag from the metal. This can only be a short period, because the melting point being much increased, by the decarbonised condition of the iron, renders it impossible to maintain the metal in a liquid state more than a few minutes, even in a large converter.

The chemical action occurs chiefly during the first period of the process; and it is then manifested by the increase of temperature from the point of fusion of pig iron to the point of fusion of the metal therefrom obtained.

The amount of caloric, corresponding to that difference of temperature, must be equivalent with the chemical energy, developed by the oxygen fixed in the converter. When that quantity of oxygen is known, then the chemistry of basic steel process becomes clear and certain, being based upon really analytical equations, and because the necessary quantities for resolving such equations can be determined on the ground of facts, but not upon speculative arguments. Until that is done the chemistry of the process, its real conditions, as well as the constitution of the slag, and its agricultural value, must remain in darkness.

The analytical or mathematical explanation alluded to, is especially wanted, while that great invention of Bessemer, completing the equally great work of James Watt and Robert Stephenson, is fast running more in the direction of manure than steelmaking. Germany appears to be the native place of that current, which is dangerous to the original process, because the formation of phosphates, in company with a proportionate quantity of overburned metal, may occur in the Thomas converter, during the period of "after-blow;" and because such impurities, being fusible, would remain in the chief product, causing its depreciation, without much probability of repaying it by the slag, which as manure is of doubtful value.

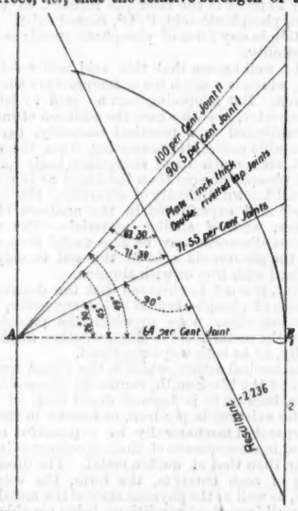
Although Herr Hilgenstock's paper may be "l'enfant terrible" to German steelmakers, yet it deserves attention in this country because such a peculiar product as four-basic phosphate of lime, notwithstanding its charm of novelty, is not the product wanted, either by metallurgists or agriculturists, seeing that it is not yet found in plants, animals, or natural phosphates.

I remain, yours faithfully,
Alexander Bobrowniski.

HELICAL JOINTS FOR BOILERS.

To the Editor of Engineering.

Sir,—Referring to the adjoined diagram, I shall feel much obliged if one of your correspondents will kindly prove that the percentage values, as marked on the several rakes, are incorrect, *i.e.*, that the relative strength of the joints



are not directly as the secants of the angles such rakes make with horizontal line A B. Given: Ideal longitudinal double-rivetted lap joint and circumferential double-rivetted lap joint of 64 per cent. of solid plate 1 in. thick.

Yours truly,
Cork, Feb. 15, 1887. R. Hartland.

ARTILLERY IN THE UNITED STATES.

To the Editor of Engineering.

Sir,—In your issue of January 21 is a communication on the defencelessness of the United States against a naval attack. The United States has no navy or large guns, it is true, but has not your correspondent overlooked the value of the pneumatic gun capable of throwing 300 lb. to 500 lb. of nitro-glycerine, and which could easily be increased to 1000 lb? The damage done by a heavy gun is due to the *vis viva* stored in the ball. To give the ball this power requires an immense force and large guns; but is not the American idea of letting the missile itself carry its own means of creating *vis viva*, which requires a cheap gun and small power, better than the system of large guns, &c., necessary to manufacture the work stored up in the ball? For the value of one large ironclad, 150 small steamers, each fitted with a "dynamite" gun, can be put into service. The gun being a mere pipe, and its machinery that necessary only to store air under pressure, would allow the United States to put into service 3000 or 4000 such boats in a month, because every available steamboat of 100 ft. in length, with such a gun, would at once become a most offensive arrangement to tackle. With twenty such boats to combat each man-of-war sent against the ports of the United States, the position of an ironclad would be rather uncomfortable. Half or two-thirds of them might be sunk, it is true, but before all of them were demolished, they would have succeeded in landing 5 or 10 tons of nitro-glycerine on the decks and against the sides of the ironclad.

Whether the explosion of 1000 lb. of nitro-glycerine on deck of an ironclad would destroy it or not, is an open question, but it seems reasonable to believe than nitro-glycerine, having some ten times the explosive force of gunpowder, would cause the crew of the man-of-war to become aware that "something had dropped." Would not the effect be to blow the deck in, to disarrange the engine, to stun the crew?

Then there is the submarine boat which has been able to stay under water for thirty minutes with its crew on the initial test, which was easily and correctly guided. What is to prevent the use of ten such boats to each ironclad? and if only one succeeded in placing 1000 lb. of nitro-glycerine under an ironclad and exploding it, it would be effective. Netting, &c., would not prevent such a boat from diving under the netting, and the use of the latter would only impede the manœuvring of the ironclad, and when thus handicapped she would be easier approached, and the better mark for the pneumatic nitro-glycerine gun. Can it be argued because 90 lb. of gun-cotton was not effective on an ironclad—as per English Government tests—that 1000 lb. of a material twice as powerful would be equally ineffective? This would give nearly twenty-five times the force of the gun-cotton, and would not this immense force have an uncomfortable effect on the unprotected bottom of any ironclad now in service?

If your correspondent will give these facts their proper value he will not find the United States so easy a prey as he seems to believe. A month's time would give the United States command of any required quantity of such boats.

Harry Revere.

Cleveland, Ohio, February 5, 1887.

THE MANUFACTURE OF MACARONI.

To the Editor of Engineering.

Sir,—Referring to the inquiry which appeared in your paper on the 18th inst., I wish to state, that the principal appliances for making macaroni and vermicelli on a large scale are a mixing and kneading machine, a specially constructed press which moulds the dough into the required shape by pressing it through narrow orifices, a cutting apparatus attached to the press, and a drying apparatus. The Maschinenfabrik St. Georgen, near St. Gall, Switzerland, has for many years made a speciality of such machinery, and has obtained gold medals for the same at international exhibitions.

I am, Sir, yours respectfully,
433, Strand. J. Wetter.

DISSOCIATION IN THE STEEL FURNACE AND IN GAS MOTORS.

To the Editor of Engineering.

Sir,—The following opinions have, during the last year, being expressed by pre-eminent authorities in the *Zeitschrift des Vereines deutscher Ingenieure*: Dr. Amie Witz considers that the influence of the gas motor walls is the chief determinate of explosive phenomena, and that it is *unnecessary to rely upon dissociation* to explain combustion in gas motor cylinders.

I may say that this opinion agrees with the one I ventured to submit some three years ago, in explanation of the superior efficiency of the compressed type of gas motor. Herr Schöttler considers that Mallard et Le Chatelier's experiments once and for ever dispose of the dissociation theory. Dr. Slaby agrees with Schöttler as to the necessity of dismissing the dissociation theory.

Mr. Crowe in his letter asks why the movement of the carbon particles does not destroy the roof of the heating, but comparatively low temperature, furnace which he illustrates; simply because the temperature is too low to seriously affect the molecular condition or produce softening of the refractory or silicious substance forming the roof. The degree of erosive action of a carbon particle is simply a function of the weight × by its momentum, and this is too small to produce any serious effect on hard surfaces, such as firebrick; if, however, the furnace heat is so intense as to produce softening of the refractory material forming the roof of the furnace, the continuous and erosive action and high kinetic energy of the carbon particles has a wearing away effect.

Mr. Crowe asks for an explanation of the phenomenon of combustion of an explosive mixture, which is divided from the zone of ignition by wire gauze. The action is simply the result of *fractional combustion*. Will Mr. Crowe give his authority for the statement that refractory silica is the best absorbent of radiant heat?

Yours faithfully,
February 19, 1887. B. H. Thwaite.

TESTING DYNAMOS.

To the Editor of Engineering.

Sir,—Any method of testing a dynamo can of course only give an approximate result.

The objection Mr. Wilkinson raises to my method I think applies equally to those of Captain Cardew and Dr. Hopkinson. The main question is: What error is introduced by assuming

$$\frac{EC}{W}=\frac{P+EC}{W} \quad . \quad . \quad . \quad (1)$$

and

$$\frac{w}{ec}=\frac{w}{ec}+\left(\frac{P_1}{ec}-\frac{P}{E_1C}\right) . \quad . \quad (2)$$

Where the conversional efficiency is not extremely low the error introduced by assuming (1) to be true will be only a small percentage one, and decreases as the efficiency increases; (2) amounts to assuming

$$\frac{P_1}{ec}=\frac{P}{EC'}$$

or that the loss of power through heating and eddy currents in a motor is proportional to the total power.

I am, yours truly,
Richard P. Fuge.

MEASURING THE DEVELOPMENT OF GREAT POWERS.

To the Editor of Engineering.

Sir,—In the discussion on triple-expansion engines, published in your issue of February 11, Mr. Halpin referred to the records of experiments made by Professor Thurston in America, in which 500 horse-power was measured by means of a brake acting on a wheel.

Will you, or some of your correspondents, Mr. Halpin for instance, kindly inform me, and others interested in the measuring of power, through your columns, where a reliable description of the apparatus used by Professor Thurston for his measuring of 500 horse-power can be found? Any information will greatly oblige your constant reader

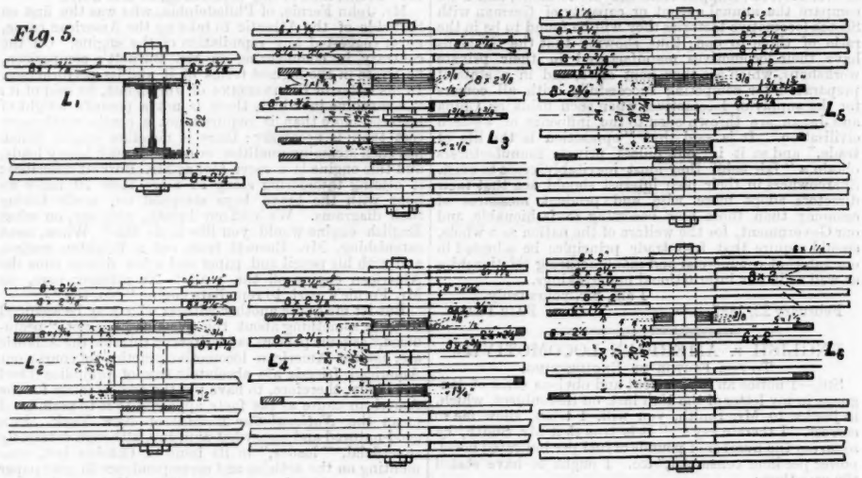
M.

THE HAWKESBURY RIVER BRIDGE, NEW SOUTH WALES.

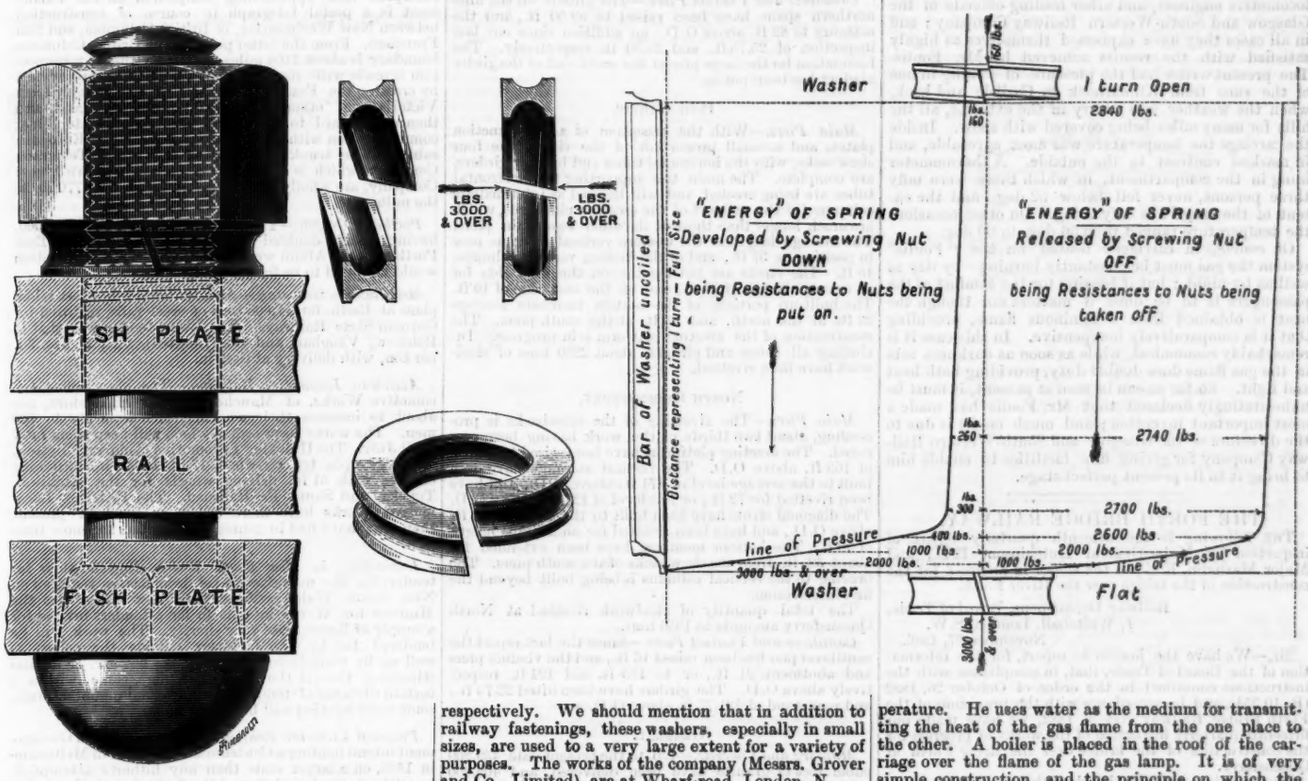
THE UNION BRIDGE COMPANY NEW YORK, ENGINEERS.

(*For Description, see opposite Page.*)

Fig. 5.



GROVER'S SPRING WASHERS.



Of the great number of patented devices for locking the nuts of permanent way fastenings, Grover's spring washer is the only one that, after standing the test of many years' service, has come into widely general use. In their original form they are sufficiently familar to all engineers; they are made from a high class steel bar of trapezoidal section coiled at a slight angle once round a mandrel, so that the ends are brought together, and made to form as it were one turn of a spiral spring. When this washer is placed over the permanent way bolt and the nut screwed down upon it, the spring is compressed and thus exerts its full energy on the fishplate and the nut of the bolt, rendering it impossible for the latter to slacken, while if in course of time any trifling elongation of the bolt takes place, the looseness that would otherwise result is effectually taken up by a corresponding extension of the washer, the elasticity of which accommodates itself within relatively wide limits, to any changes that may arise from temperature or other causes. It will be readily seen that this ingenious and extremely simple device, while being a thoroughly efficient nut lock, maintains the bolt fastenings always tight and thoroughly up to their work, and at the same time sufficient elasticity is introduced to avoid the inconveniences inseparable from rigid connections, which are especially objectionable in permanent way. As we said above, we are describing what is really a very old invention, the character of which has been fully tested by time and service, no less than 125,000,000 being now in use on the leading European railways, including the whole of the vast system of the Paris, Lyons, and Mediterranean Company.

Recently Mr. Grover has introduced a striking improvement in his washers, without, however, affecting the principle of the design, and which is illustrated in the illustrations above. Instead of using a trapezoidal bar he now employs one of I section for the washers, and by this judicious distribution of material he of course largely increases the strength, while the operation of coiling distresses the steel far less than with the old section. The diagram given above embodies the results obtained in an experiment with a washer of the new form, the object being to ascertain the amount of energy developed by the spring during the last turn of the nut in screwing up, and the resistance offered by it during the first turn in unscrewing. As will be seen, the total useful energy exerted by the spring in keeping the joint tight is at least 3000 lb., and that the resistance to the nut in running back is such as to render working loose under the vibration of traffic, quite impossible. The work done, as shown in the diagram, is irrespective of the hold taken by the cutting edges of the washer on the fishplate and nut respectively. We should mention that in addition to railway fastenings, these washers, especially in small sizes, are used to a very large extent for a variety of purposes. The works of the company (Messrs. Grover and Co., Limited), are at Wharf-road, London, N.

THE HAWKESBURY BRIDGE.

We publish this week a two-page plate forming the first part of a series of detailed illustrations of the great bridge now in course of construction and which will be erected in New South Wales over the Hawkesbury River, where it will form a link of the Southern and Northern Junction Railway. It will be remembered that the Colonial Secretary instructed Sir Saul Samuel to invite tenders and designs for the construction of the bridge, and that in response to this invitation fourteen offers were made from the leading bridge constructors of the world. The tenders ranged from 296,350*l.* to 702,384*l.*, and the time for completion from two to four years. Both the Committee of Engineers appointed to select the design and Sir John Fowler, the consulting engineer of the colony, were unanimous in recommending the design of the Union Bridge Company of New York, of which we commence the publication in the current issue. As is well known, nearly all of the steel used is being manufactured in this country.

NEW SYSTEM OF HEATING RAILWAY CARRIAGES.

The efficient and economic heating of railway carriages in northern climates has long been a vexed question, and many inventors have endeavoured to solve it; but the success which has hitherto attended their efforts has in most instances been of a qualified character. It is satisfactory to know, however, that there is now a prospect of the object aimed at being attained in a thoroughly successful manner. In this case the inventor is Mr. William Foulis, M.Inst.C.E., the manager-in-chief to the Glasgow Corporation Gas Commissioners. That gentleman has devoted much attention during the past year or two to the practical utilisation of coal gas as a heating agent, and more especially in devising various ingenious forms of water-heaters of almost instantaneous action. His newest invention involves a further application of the same principles as are turned to account in his water heaters for domestic and other purposes.

In applying his skill to the heating of railway carriages Mr. Foulis takes advantage of the fact that large numbers of them are already fitted with various forms of gas lamps for supplying light; and his aim has been to bring the heat that is developed in the roof of the carriage while the gas is alight down to the floor of the compartment, so as thereby to keep the feet of the passengers comfortably warm, and the whole atmosphere of the compartment at an agreeable temperature. He uses water as the medium for transmitting the heat of the gas flame from the one place to the other. A boiler is placed in the roof of the carriage over the flame of the gas lamp. It is of very simple construction, and the principle on which the heater works is that the heat from the flame comes into contact with the boiler at the point where the water is hottest and leaves it where it is coldest. From this boiler there descend two pipes about ¾ in. in diameter which are connected to two annular tubes placed underneath the carriage seat. The course which the two pipes take is down through the wooden partition separating the contiguous compartments. Hot water circulates through these pipes and annular tubes, and it returns to the boiler after having given off its heat. The reversal of the current is accomplished by allowing the hot water from the boiler to ascend in a tube a few inches in length, on the top of which there is a small valve. Having passed up this tube, and being unable to return to the boiler, the hot water is made to circulate downwards through the pipes. The annular tubes already referred to are about 3½ in. in diameter and about 8 in. long. They are laid at an angle under the seat, the upper end being raised as far as practicable. The pipe which conveys the hot water is connected to the top of these tubes, and that which carries the return current is connected with the bottom of the same.

Owing to the fact that the tube is placed at an angle and that it is heated, an induced current of air is made to pass through it; and as the air enters the tube at the cold end, and leaves it at the hot end, it absorbs the maximum amount of heat from the water. The air flows from these tubes or heaters in a constant stream at a temperature of from 80 deg. to 90 deg. It has been found that the ordinary size of gas flame is quite sufficient to do the heating of a compartment, though the consumption of gas is less than one cubic foot per hour, and even during the coldest days of winter.

As regards the probability of the water in the apparatus freezing in cold weather when the carriage is not in use, it should be mentioned that congelation is completely prevented by mixing a given quantity of glycerine with the water. By way of testing the efficiency of this non-freezing mixture, the experimental carriage which has been placed at the service of Mr. Foulis was left exposed at night on a railway siding during the coldest weather of the past winter, without the slighest indication of freezing taking place in the water to which the glycerine had been added.

We may mention that the carriage used is a composite one of four compartments, the property of the Glasgow and South-Western Railway Company. The internal construction of the carriage was entirely rearranged under the superintendence of Mr. Foulis. During the past two months or so numerous experimental runs have been made with this carriage as

part of a regular passenger train, several of them being to and from Carlisle. On one or two occasions the patentee has been accompanied by Mr. Smellie, locomotive engineer, and other leading officials of the Glasgow and South-Western Railway Company; and in all cases they have expressed themselves as highly satisfied with the results achieved by Mr. Foulis. The present writer had the pleasure of joining in one of the runs from Kilmarnock to Carlisle and back, when the weather was wintry in the extreme, all the hills for many miles being covered with snow. Inside the carriage the temperature was most agreeable, and in marked contrast to the outside. A thermometer hung in the compartment, in which there were only three persons, never fell below 52 deg., and the extent of the range was only 2 deg. On other occasions the temperature ranged from 56 deg. to 60 deg.

Of course, in carriages heated on the "Foulis" system the gas must be constantly burning—by day as well as by night; but if heating for the comfort of the passengers is to be done it matters not though the heat is obtained from a luminous flame, providing that it is comparatively inexpensive. In this case it is remarkably economical, while as soon as darkness sets in the gas flame does double duty, providing both heat and light. So far as can be seen at present, it must be unhesitatingly declared that Mr. Foulis has made a most important invention; and much credit is due to the directors of the Glasgow and South-Western Railway Company for giving him facilities to enable him to bring it to its present perfect stage.

THE FORTH BRIDGE RAILWAY.

The following is the fifteenth quarterly report of inspection by Major-General Hutchinson, R.E., and Major Marindin, R.E., of the works in progress for the construction of the bridge over the River Forth.

Railway Department, Board of Trade,
1, Whitehall, London, S.W.
November 27, 1886.

Sir,—We have the honour to report, for the information of the Board of Trade, that, in compliance with the instructions contained in the order of October 26, 1882 (R. 10,354), and in accordance with the provisions of the Forth Bridge Railway Act of 1882, we have made our fifteenth quarterly inspection of the works in progress for the construction of the bridge over the River Forth at Queensferry.

The erection of the steelwork of the superstructure, of which a very large proportion has now been prepared and fitted in the yard, is being carried on actively at the main piers at South Queensferry, Inch Garvie, and North Queensferry, where, since the date of our last inspection, a large amount of work has been done, while steady progress has also been made in the masonry of the piers of the viaduct approaches and the lifting of the girders.

The nature of the work done and the present condition of the structure are briefly described below, and we also annex an elevation of the bridge on which the portions actually completed are coloured red, and the steelwork which has been erected, but is not yet rivetted up, is coloured yellow.

Temporary Works.

The principal additions which have been made to the plant are for the purposes of the erection of the superstructure, and consist of compressors, accumulators and rams for high-pressure rivetting, additional machines for rivetting the 8 ft. and 12 ft. tubes (such as were described in our last quarterly report), steam cranes, steam winches, hydraulic rams, and other appliances of a similar kind; some specially designed plant for the erection of the bottom members of the cantilevers is also in hand, consisting of rectangular frames 20 ft. square and 64 ft. long, constructed of angle bars, and in sections. When in position these frames will encircle the tubes, and rest partially upon them, the lower portion of each frame being planked over to form a stage for workmen, and the top carrying a crane with hydraulic lifting, slewing, and traversing motions, by means of which the plates will be placed in position. The plates will be delivered by a carriage, hanging from a steel wire rope, and drawn out along it from the pier to the point at which the frame above described is situated.

When a length of the tube has been built it will be rivetted up by a machine, and a section of the frame will then be transferred by the crane from the back to the front, so that the frame will advance step by step concurrently with the construction of the tube.

Permanent Works—South Queensferry.

Main Piers.—The four skewbacks, with the horizontal tubes and bracing girders connecting them, are practically complete, only a small portion of the special rivetting inside the skewbacks and the fixing of a few plates outside the foot of the vertical columns having still to be done. The curved bottom member of the cantilever at the north-west pier is bolted up and partially rivetted for a length of 40 ft. and the similar members on the other piers for lengths of 20 ft. The bracing between the vertical columns is being erected. The method of erection of the upper portion of the main and bracing columns, described in our last report as being in operation at North Queensferry, has been adopted here also.

The vertical columns have been built up to a level of 116 ft. above O.D., and the diagonal struts to an average level of 108 ft. above O.D. Lengths of about 16 ft. have been rivetted up on the north-west, south-west, and south-east vertical columns, and on the south-west diagonal strut. The erecting platform stands at a level of 99 ft. above O.D., and including all tubes and girders, about 1760 tons of steelwork have now been rivetted.

Cantilever and Viaduct Piers.—The girders on the nine northern spans have been raised to 89.50 ft., and the masonry to 82 ft. above O.D., an addition since our last inspection of 25.75 ft. and 25.50 ft. respectively. The foundation for the large pier at the south end of the girder viaduct has been put in.

Inch Garvie.

Main Piers.—With the exception of a few junction plates, and a small proportion of the rivets, the four skewbacks, with the horizontal tubes and bracing girders, are complete. The main ties supporting the horizontal tubes are being erected, and will be used as intermediate columns for the support of the erecting platforms, which are much longer than those at the other two main piers. The average length of the western vertical columns now in position is 37 ft., and of the eastern vertical columns, 18 ft. The struts are put together on the west side for an average length of 16 ft., and on the east side of 10 ft. The built-up portions of the bottom members average 26 ft. at the north, and 28 ft. at the south piers. The construction of the erecting platform is in progress. Including all tubes and girders, about 2280 tons of steelwork have been rivetted.

North Queensferry.

Main Piers.—The rivetting of the skewbacks is proceeding, about two-thirds of the work having been executed. The erecting platforms have been raised to a level of 168 ft. above O.D. The vertical columns have been built to the average level of 171 ft. above O.D., and have been rivetted for 72 ft., or to a level of 124 ft. above O.D. The diagonal struts have been built to the level of 170 ft. above O.D., and have been rivetted for an average length of 50 ft. The bottom members have been extended for about 32 ft. from the skewbacks of the south piers. The bracing to the vertical columns is being built beyond the first intersection.

The total quantity of steelwork rivetted at North Queensferry amounts to 1950 tons.

Cantilever and Viaduct Piers.—Since the last report the cantilever pier has been raised 16 ft., and the viaduct piers and abutment 21 ft., or to 123 ft. and 124 ft. respectively above O.D. The girders have been lifted 23.75 ft., and now stand at 131.75 ft. above O.D.

General.

Masonry and Concrete.—Up to the present date 439,200 cubic feet of granite have been delivered, and 409,200 cubic feet set, and about 102,000 cubic yards of rubble masonry and concrete work have been built.

Steelwork.—The fitting of the plates and angles at the junctions of the crossing of the 8 ft. tubes between the vertical colums, and the bracing connected with the latter are practically complete for both North and South Queensferry. The internal viaduct for the space between the piers at North and South Queensferry has been drilled and fitted, and a commencement has been made with that for Inch Garvie. A considerable portion of the first bay of the bracing of the bottom members for the south end of the cantilever at North Queensferry has been drilled and fitted. The junction lengths of the ties, struts, and columns have been fitted to the main horizontal tension members for the tops of North and South Queensferry vertical columns. The fitting of the parts forming the junction at the ends of the first bays of the bottom members of all the cantilevers has been commenced, and those for South Queensferry north-east and north-west, and Inch Garvie, north-east and north-west, are well advanced.

In all 33,007 tons of steel have been delivered.

The average number of men employed on the works during the past quarter has been 2960, and the number actually employed on November 20th was 3397.

During the last quarter the weather may be considered to have been favourable, inasmuch as no great wind pressures have been recorded, but, having in view the possibility or probability of the occurrence of gales of wind during the coming winter and spring, as well as to guard against strains produced by the unsupported overhanging weight of the tubes, &c., themselves, we desire to draw attention to the necessity for the greatest possible care being taken to secure, by means of temporary ties and struts or other appliances, the vertical columns, diagonal struts, and bottom members of the cantilevers, in such a manner that no undue stress may be brought upon the junctions with the skewbacks while these members are still in an unfinished state, and still unsecured by the permanent ties and struts which will provide for the stability of the structure when completed.

The quality of the work, so far as we can judge from the opportunities afforded by a quarterly examination, continues to be excellent.

We have, &c.,
C. S. Hutchinson, Major-General, R.E.
F. A. Marindin, Major.

The Assistant Secretary,
Railway Department, Board of Trade.

A Large Boiler.—One of the largest boilers ever built in the United States has just been tested at the shops of Messrs. Davies and Son, Hartford, Connecticut. It will be at once shipped to the New York Post Office, where it is to take its place beside another of like size made by the same firm. The pair will be used to generate steam for the dynamos which operate the electric lights of the building. The boiler weighs nine tons, and has 1202 square feet of heating surface, giving 186 horse-power.

FOREIGN AND COLONIAL NOTES.

Telegraphy in the Great North-West.—An important enterprise now approaching completion on the Pacific coast is a postal telegraph in course of construction between New Westminster, in British Columbia, and San Francisco. From the latter point to the British Columbia boundary is about 1100 miles, and from thence a connection is made with the Canadian Pacific telegraph system by crossing the Fraser. All parts of the country from Victoria and other points on Vancouver Island, and thence eastward to Winnipeg, are brought into direct communication with the Atlantic seaboard and European cables. The trunk line wires of the Postal Telegraph Company, which is independent of the Western Union Company, are wholly of copper, and weigh over 770 lb. to the mile.

Portland, Oregon.—This city has a population of 40,000, having nearly doubled since 1880. If Portland, East Portland, and Albini were taken together, the population would be found to be fully 50,000.

Steel Rails in Germany.—An adjudication has just taken place at Berlin for 11,800 tons of steel rails required for German State Railways. The lowest tender was that of Bolckow, Vaughan, and Co. (Limited), viz., 5*l.* 18s. 3d. per ton, with delivery at Stettin.

American Locomotive Building.—The Manchester Locomotive Works, of Manchester, New Hampshire, are about to increase their working force from 300 to 500 men. The works have orders which will keep them busy until July. The Hinckley Locomotive Company, Boston, are busy upon ten six-wheel 17 in. by 24 in. switching engines with 51 in. driving wheels for the Atchison, Topeka, and Santa Fe Railroad. The Pittsburg Locomotive Works have more orders on hand at present than they have had in course of execution for some time past.

Locomotives in New South Wales.—Specifications for tenders for the manufacture of locomotives required on New South Wales railways are now ready, and the Minister for Works intends to have tenders invited for a supply of locomotives very shortly. The work will be tendered for by manufacturers outside the colony as well as by manufacturers within it; but Mr. Lyne has stipulated that if the colonial tenders come within a certain distance of tenders from external manufacturers, some consideration will be shown them.

Proposed Victorian Exhibition.—The Victorian Government intend holding a Centennial Exhibition in Melbourne in 1888, on a larger scale than any hitherto attempted, to celebrate the foundation of the first colony in Australia. It will be open to all nations, and will follow the festivities, which will take place in Sydney to mark the centenary of New South Wales. It is considered that the Exhibition affords the best opportunity of showing the progress of Victoria and Australia generally; and as Melbourne possesses a suitable building for the purpose, the proposal is looked upon with favour. The Prince of Wales will be invited to open the Exhibition.

A New Zealand Railway Contract.—It is stated that Mr. Owen, contractor of Sydney, has entered into a contract to finish the Kaihu Valley Railway, New Zealand, from Dargaville to Kaihu Bush for 60,000*l.*

The Panama Canal.—M. de Lesseps in the course of a recent speech at Paris, stated that 5,500,000*l.* was still needed to complete the Panama Canal.

Pig Iron in the United States.—The production of pig iron in the United States last year was 6,272,000 tons. The corresponding production in 1885 was 4,529,869 tons; in 1884, 4,589,613 tons; in 1883, 5,146,972 tons; in 1882, 5,178,122 tons; in 1881, 4,641,564 tons; in 1880, 4,295,414 tons; in 1879, 3,070,875 tons; in 1878, 2,577,361 tons; and in 1877, 2,314,585 tons. It will be seen that the production of last year was the largest on record.

German Coal Mining.—The extraction of coal in the Sarrebruck district last year was 5,821,010 tons. The corresponding output in 1885 was 6,040,031 tons.

Hamburg.—In the course of last year 6913 ships of an aggregate burden of 3,792,000 tons, entered the port of Hamburg. The corresponding arrivals in 1885 were 6790 ships of an aggregate burden of 3,787,000 tons.

The Simplon.—Another proposal has been made for carrying a tunnel through the Simplon. The length of the proposed tunnel is 10 miles 766 ft., so that, if carried out, it will be the longest work of its kind ever attempted. The chief difficulty anticipated is the heat of the air in the uncompleted tunnel, but it is hoped and expected that this difficulty may be overcome by a system of energetic ventilation. The cost of the tunnel, if constructed, so as to accommodate two lines of rails, is estimated at 2,480,000*l.* The time assigned for the completion of the tunnel is six years.

Victorian Railways.—Messrs. Nicholl, Gray, and Tamlyn, the contractors for the Echuca and Tatura Railway,[1] are making rapid progress with the construction of the line. The whole of the earthworks, and a considerable portion of the fencing, have been completed. Men are busily engaged in erecting the bridges, of which an unusually large number have to be provided, owing to the marshy nature of a portion of the country intersected by the line. Some difficulty has been experienced in procuring the long timber required for the bridgework, but now that supplies are to hand this portion of the contract is being pushed on with great rapidity. The rails have been laid a distance of three miles from both Echuca and Tatura, and Messrs. Nicholl, Gray, and Tamlyn hope to have the line completed as far as Kyabram in time for the harvest.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1883.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

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Copies of Specifications may be obtained at 38, Cursitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, addressed to H. READER LACK, ESQ.

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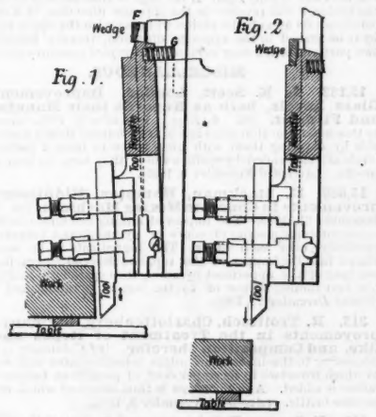
Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

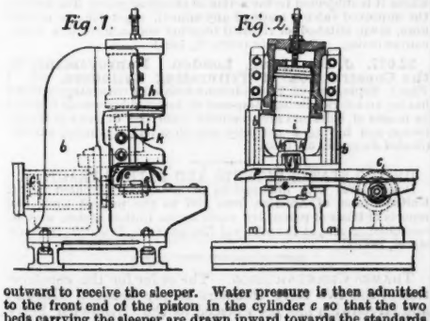
MACHINE TOOLS.

15,327. A. A. Rickaby, Sunderland, Durham. Improvements in Slotting Machines. [8*d.* 4 *Figs.*] December 14, 1885.—This invention relates to certain fittings by means of which the tool on the return stroke is removed out of contact with the surface of the article being slotted as the feed is acting for the next. By which contact, in existing machines, the cutting edge of the tool is destroyed and frequent grinding and setting are required. The tool-holder instead of being rigidly fixed to the sliding ram, is carried upon the bolt A at the lower end of the ram. The sliding ram carries by brackets at each side of the ram two bars, upon each of which are two tappets adjustable by set screws to suit the stroke required by the work being slotted, and each fitted with an elastic buffer piece. The sliding ram carries a crosshead F with a wedge-



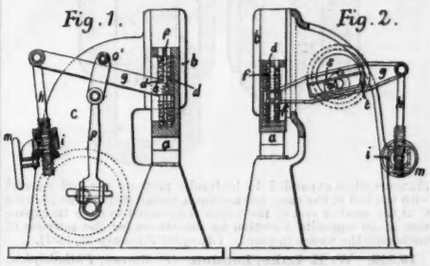
shaped cavity which fits over the wedge-shaped top of the tool-holder, and secures it in position when the cut is being made (Fig. 2), but when the cut is finished the projecting ends of the crosshead F coming in contact with the lower pair of tappets releases the top of the tool-holder, which is forced outward from the ram by the spring G upon the bolt A, and the tool makes the return stroke in the position shown in Fig. 1. When the return stroke is nearly completed, the crosshead F comes into contact with the upper pair of tappets, and is forced down over the wedge-shaped top of the tool-holder, forcing it back against the ram into the position shown in Fig. 2, ready for the fresh cut, the feed having advanced the work on the table the required extent during the return stroke of the tool. (*Accepted December* 10, 1886).

2035. P. Kirk, Workington, Cumberland. Improvements in the Manufacture of Rolled Sleepers and in Apparatus Used therein. [8*d.* 3 *Figs.*] February 12, 1886.—The present invention has for its object to finish quickly without reheating, combined chairs and sleepers made of rolled steel or iron. To this end a double press is employed which operates upon the two chairs of the sleeper simultaneously. The figures illustrate the parts which operate upon one of the chairs, and are arranged symmetrically to the duplicate parts on the other side of the cylinder *c*. The sleeper *f* to be operated upon having the jaws to form the two chairs roughly raised up from the sleeper is placed upon the beds *e* which have been pushed



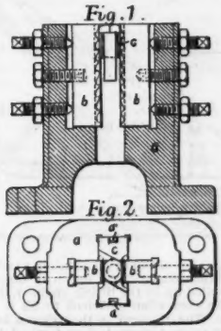
outward to receive the sleeper. Water pressure is then admitted to the front end of the piston in the cylinder *c* so that the two beds carrying the sleeper are drawn inward towards the standards *b*. By this movement the jaws upon the sleeper pass between cheeks and are pressed inward towards the shaping mandrels *l*, and are thus brought nearer to their intended form. When the jaws upon the sleeper have been brought into position below the dies *k* carried by the rams *i* of the hydraulic cylinders *h*, the dies *k* are brought down simultaneously by admitting water above the rams, and the jaws becoming pressed between the dies and the mandrels, are thereby moulded to their finished forms. The axis of the ram *i* in Fig. 2 is inclined from the perpendicular according to the amount of cant of the finished chair, and the faces of the beds *e* are correspondingly inclined. (*Accepted January* 15, 1887).

2373. J. Wild, Chadderton, Lancaster. Improvements in Power Hammers. [8*d.* 2 *Figs.*] February 18, 1886.—The improvements have reference to cushioning the hammer-head, and regulating the length of the stroke and the weight of the blow. The hammer-head *a* works between guides *b*, and is chambered out so as to contain two fixed bars *d*, *d*, upon which a pair of blocks *e* are capable of sliding freely up and down. Between these blocks and the top and bottom of the chamber are a series of spiral springs *f* coiled round the bars *d*. The sliding blocks *e* are connected to one extremity of a lever *g*, the other end of which is connected to a rod *h*. The lower extremity of this rod *h* is screwed through a nut *i*, which is not only capable of turning upon its vertical axis, but is also so jointed to the frame *c* as to be able to oscillate thereon in accordance with the curve described by the end of the lever *g*. By turning the nut *i* by means of the



handwheel *m*, the rod *h* may be screwed more or less through the nut, and thus the force of the blow of the hammer-head may be adjusted with the greatest nicety, whilst the springs *f* act as a cushion to the hammer-head at each end of its stroke. The up-and-down motion is imparted to the hammer-head in Fig. 1 by means of a sliding bracket *o* mounted upon the lever *g* and connected by a connecting-rod *p* to the crank-pin of the driving shaft. The bracket *o* may be fixed in any position on the lever *g* by means of a clamping nut. Thus the length of the stroke of the hammer-head will be decreased or increased according as the bracket *o* is fixed nearer to or further from the hammer-head. In Fig. 2 the lever *g* is operated by means of a block *s*, which slides in a slot *t* formed in the lever, and which block receives a direct revolving motion from the adjustable crank-pin upon the driving shaft without the intervention of a connecting-rod. (*Accepted December* 14, 1886).

2879. H. H. Lake, London. (*A. Urban and Sons, Vienna.*) **Improvements in Apparatus for Shaping and Finishing Bolt-Heads and Nuts, and for similar Purposes.** [8*d.* 11 *Figs.*] February 27, 1886.—This apparatus consists of a cast-iron body *a* provided with steel cutters *b*, and clamping jaws *c*. The cast-iron body *a* with the cutters *b* secured in it by screws is mounted on a machine suitable for forcing or drawing. The bolt-heads or nuts, &c., are first placed between the clamps *c* and together inserted into the cast-iron body *a* which has guides

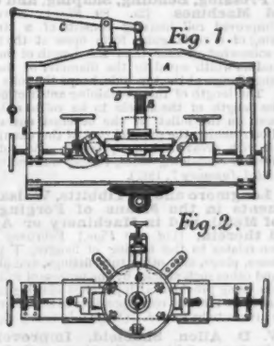


a'. The plunger of the drawing machine now draws the nut together with the clamps through the apparatus past the steel cutters *b*. These cutters have a number of inclined teeth and are made slightly tapering longitudinally, so that when placed in position they stand a little further apart at their upper than at their lower ends. When the bolt-head or nut is passed between the cutters, the superfluous metal is removed in successive shavings, the last shaving removed by the lowermost tooth being only a fine finishing shaving. (*Accepted December* 21, 1886).

12,580. H. M. Myers, Beaver Falls, Penn., U.S.A. Improvement on Machine for Splitting and Forming Sockets in Blanks for Shovels, Spades, and Scoops. [8*d.* 7 *Figs.*]—October 4, 1886.—The improvements comprise a reciprocating head having a hammer attached to it and carrying a cutter, in combination with blank clamping jaws, one of which has an anvil formed on it in such relation to the hammer on the head that the splitting of one blank may be closed by the same stroke of the head that is splitting another blank. (*Sealed January* 11, 1887).

12,657. T. Fowler, Shelton, and T. B. De Forest, Birmingham, Conn., U.S.A. Improvements in Wire Nail Machines. [11*d.* 13 *Figs.*] October 5, 1886.—The wire is fed from a coil or reel through straightening rollers and then passed through the machine. When between the dies both pairs, through the medium of the levers, links, and cam on the main shaft, are caused to close tightly upon it. As the normal position of the die bars is with the pointing die bars, separated from the grasping die bars, there is a short length of wire between the vertical surfaces of the closed dies. The pointing die bars are now—by block toggle levers, follower, and cam—forced up against the grasping die bars, and the short length of wire is upset into a head which is suitably flattened between the vertically abutting faces of the four dies. At the completion of this operation the die bars are separated in both directions by the action of springs. The feed now lays hold of the wire and draws it forward the proper distance for the next operation of the dies. (*Sealed January* 11, 1887).

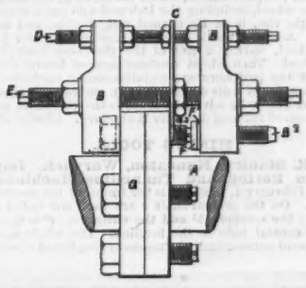
14,689. J. O'Brien, St. Louis, Missouri, U.S.A. Improvements in Flanging Machines. [8*d.* 4 *Figs.*] November 12, 1886.—This invention relates to a machine for flanging boiler heads. In the upper part of the frame A of the machine is supported a vertical shaft B, adapted to have end movement and to be lifted by a lever C. When the machine is at work the shaft B is held down by a jam nut D in the form of a hand-wheel screwing on the threaded shaft B, jamming against the frame A. Secured to the lower end of this shaft is the flanging disc G having rounded lower edges. Beneath the disc is a revolving table L supported on a vertical shaft journalled in the lower part of the frame A and turned by suitable mechanical means. The piece of metal to be flanged is placed upon the table L, the



disc G having been raised out of the way by the lever C, and the disc is then lowered until it rests upon the piece of metal, where it is clamped and held by the jam nut D. When the table L is turned the disc and plate of metal are turned with it, and the edge of the latter is turned up by blocks provided with friction rollers and held in sliding plates moved to and from the table by feed screws. As the shafts are turned, the inclination of the blocks and friction rollers is changed by means of cog segments and worms, and the incline is made steeper as the flange is completed. (*Accepted December* 14, 1886).

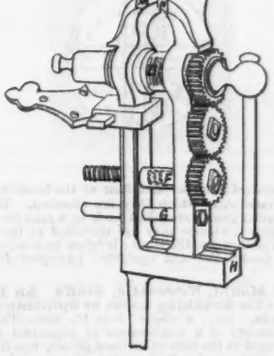
SMALL TOOLS.

341. S. W. Allen and A. Kellar, Cardiff. An Improved Apparatus for Extracting Coupling Bolts from the Shafting of Marine and other Engines. [8*d.* 6 *Figs.*] January 8, 1886.—A is the shaft with the flanges *a* coupled together by bolts. B is a jaw forked at its lower extremity to enable it to embrace the head of the bolt a^3 to be removed. B^1 is a similar jaw, C is the supplementary jaw. The nuts having first been taken off the bolts, the jaws B and C are fixed on opposite sides of the coupling, and are screwed up by means of the screws D and E. The third jaw B^1 is next placed in



position, leaving a space between the nose of the expelling pin B^2 and the end of the bolt, into which space a pair of wedges F can be driven as far as is necessary to bring the bolt to be expelled into a condition of stress, as far as its hold in the holes of the flange is concerned. While the bolt is in this condition of stress a smart blow from a hammer is delivered upon the end of the pin B^2 before which the bolt moves. The wedges F are then driven in and the blows on the pin continued until the expulsion of the bolt is effected. (*Sealed January* 7, 1887).

3353. J. Evans, Sheffield. A New Standing or Portable Parallel Vice. [8*d.* 6 *Figs.*] March 10, 1886.—The front jaw N is constructed to slide parallel to the back jaw by means of two or more screws D, F, which are worked by three or



more cogwheels. A bearing bar G is fastened to the sliding side and passes through the fast side. The bottom of the sliding side slides on a projecting bar H. Inventor specifies three claims which simply enumerate the advantages of parallel vices in general. (*Accepted January* 15, 1887).

11,855. T. Brown, Sheffield. An Improvement in

Picks and similar Tools, and their Attachments to Shafts. [6*d.* 10 *Figs.*] September 17, 1886.—The blade and its notched part are made of wedge section with rounded upper edge so as to fit into the rounded loop of a socket having flanges that are rivetted together and embrace the shaft. The pick is secured in its socket by means of a wedge made with a notch in its underside and stop shoulders. (*Sealed January* 4, 1887).

ROLLING AND FORGING.

14,290. J. Robertson, Govan, Lanark, N.B. Improved Constructions of Housings for Rolling, Drawing, Pressing, Bending, Shaping, and Crushing Mills and Machines. [2*s.* 89 *Figs.*] November 21, 1885.—The improved roll housing consists of a strong metal channel casting of a rectangular form open at the top side, its depth being somewhat greater than the length of the rolls to be used in it, and its width equal to the diameter of the two rolls. An overlapping flange at the top side keeps the rolls from rising up endwise. The length of this containing antifrictional-housing is equal to the length of the article to be rolled out in it. The rolls are drawn on the billet in the bevelled entrance of the channel, and on reaching the parallel part of the channel, close in on the billet with great drawing pressure, and roll along the channel against its containing sides, rolling out and compressing the rod. (*Sealed January* 7, 1887).

2816. T. Longmore and T. Tibbitts, Walsall, Staffs. Improvements in the Means of Forging Certain Articles of Metal, and in Machinery or Apparatus Employed therein. [11*d.* 40 *Figs.*] February 15, 1886.—This invention relates to the forging of flanges, T pieces, drop spouting crosses, plugs, and other tube fittings, and also the forging of hoes and other such articles by the process of rolling through rolls, the rolls being provided with punches working into sinkings or recesses, and the recesses corresponding to the external configuration of the article to be forged. (*Sealed January* 25, 1887).

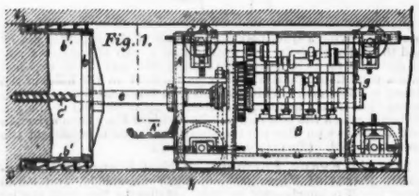
2859. W. D. Allen, Sheffield. Improvements in the Manufacture of Strengthening or Safety Hoops for Locomotive and other Cranks. [8*d.* 9 *Figs.*] February 27, 1886.—The hoops are made without a weld or join by forging or rolling weldless hoops or rings, and blocking, hammering, stretching, or stamping them to fit the webs of the cranks. (*Accepted December* 17, 1886).

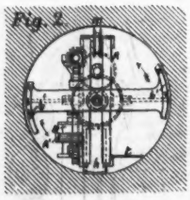
3329. S. Fox, Leeds. Improvements in the Manufacture of Corrugated Furnaces and Flues for Steam Boilers. [8*d.* 3 *Figs.*] March 9, 1886.—According to this invention the corrugating rolls are formed and arranged in such a manner that the metal of the furnace or flue when finished shall be of greater thickness at the inner and outer ridges than at the sides of the inner and outer channels of the corrugations, the metal being reduced in thickness at the last-mentioned parts in the process of corrugating. (*Accepted January* 8, 1887).

13,740. H. H. Lake, London. (*H. W. Fowler, Chicago, Ill., U.S.A.*) **Improvements in the Manufacture of Wheels for Railway and other Vehicles, and in Apparatus therefor.** [11*d.* 14 *Figs.*] October 26, 1886.—The chief object of this invention is to economically produce cast-steel wheels which are integral or solid and truly circular, and which have the metal at the tread hardened and evenly condensed in radial and peripheral lines, whilst the metal at the interior portions of the wheel, including the hub and web and a considerable portion of the rim, is in its normal soft, ductile, and tenacious condition. A wheel blank is cast larger in diameter than the finished wheel, having a rim of the thickness desired in the finished wheel. Then whilst confined against lateral expansion, portions of the periphery are simultaneously subjected to the action of a series of rolls which laterally embrace portions of the rim, and are gradually advanced towards the centre of the blank until the desired reduced diameter is obtained. (*Sealed February* 1, 1887).

MINING TOOLS.

1449. R. Stanley, Nuneaton, Warwick. Improvements in Boring and Tunnelling Machines. [11*d.* 10 *Figs.*] February 1, 1886.—A is the frame of the machine, B is the motor. On the central shaft *a* are fixed the radial arms *b*, which carry the scrapers b^1 and the cutters *c*. c^1 is the drill for drilling a central hole in the heading. The whole machine is moved forward automatically by means of roughened wheels *m* and

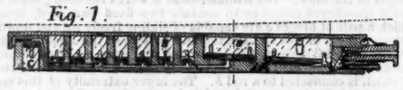


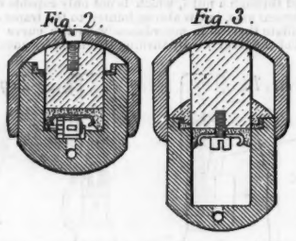


A working against the roof and floor of the heading, below and above the frame A to which they are attached. The cuttings from the annular groove are raked back by a man on the seat A^1, on to the plate *f*, whence they are shovelled to the rear of the machine. The thrust of the shaft *e* is taken by a movable plate *g* in a bearing fixed to the back uprights. (*Accepted December* 21, 1886).

9123. E. Mould, Newcastle, Staffs. An Improved Appliance for Breaking Loose or Splitting all Kinds of Minerals. [8*d.* 9 *Figs.*] July 13, 1886.—The improved appliance consists of a combination of segmental and central wedges arranged in the form of inclined planes, together forming cylinders or portions of cylinders, and so arranged that, when longitudinal motion is imparted to the central wedge or series of wedges, such motion causes the segmental wedges to expand or travel laterally, the resulting effect being somewhat analogous to that of an expanding mandrel. The motion may be imparted to the central wedge or series of wedges by means of a central screw or screws, or by means of a central tube conveying water or air under pressure to a ram, whereby the central wedges are forced to travel in a longitudinal direction. (*Sealed January* 7, 1887).

2522. W. S. Shreeve, Shrewley, Warwick. Improved Hydrostatic Mining Wedge. [8*d.* 11 *Figs.*] February 22, 1886.—The improved mining wedge consists of a case having chambers arranged in wedge shape and provided with gun-metal plungers B in such a manner that the outer ends of the



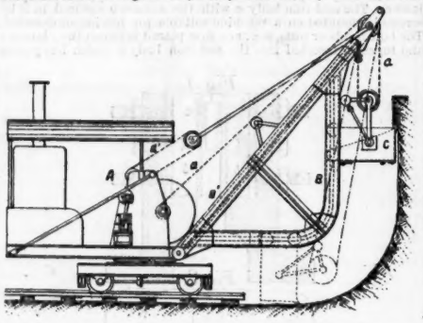


plungers when expanded by hydraulic pressure are not parallel with the bed of the case, but assume a wedge shape. The plunger C at the smaller end of the wedge is arranged to have its expansion in an opposite direction to the others for the purpose of anchoring the wedge in place. (*Accepted January* 12, 1887).

10,556. W. R. Lake, London. (*E. Moreau, Philadelphia, U.S.A.*) **Improvements in Rock-Drilling Machines.** [1*s.* 3*d.* 59 *Figs.*] August 17, 1886.—The improvements relate particularly to hand-rock drilling machines in which are combined a series of reciprocating hammers arranged to revolve in concert about a common centre, each being successively brought into line with the drill tool, and after being first forced back by cams against a spring, released to deliver its blow upon the head of the drill tool, the drill tool itself revolving about its own axis through a portion of a revolution, between the hammer blows. (*Sealed December* 17, 1886).

EXCAVATING.

10,207. J. Garvie, London. Improvements in Excavators. [8*d.* 2 *Figs.*] August 10, 1886.—A is an ordinary locomotive steam crane with lifting chain *a* and derricking chain a^1 operated in the usual manner. B are the guides attached to the jib B^1, and having stops b^1 to limit its movement. They are curved at their lower end to allow the bucket to cut its own way from the bottom of the excavation. The bucket C is guided by rollers which run in the angle-irons of B, and is operated by the lifting chain *a*. The bucket having been lowered to the stops b^1 at the bottom of the guides B, the jib-head is, by means of the



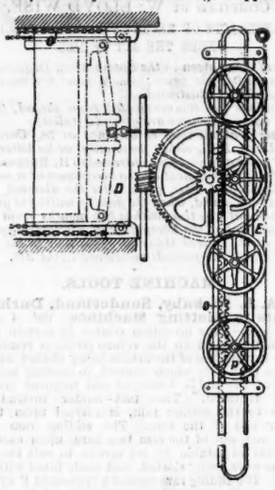
derricking chain a^1, let out until the bucket touches the ground at the bottom of the excavation (as shown in dotted lines). The bucket is then pulled up by the lifting chain *a*, taking a cut in in the face of the excavation sufficient to fill it by the time it reaches the top. The jib-head is then drawn back to free the bucket from the excavation and slewed round in the ordinary manner until the bucket is directly over the truck placed to receive its contents. The bucket having been discharged by means of a door in its bottom, the crane is then slewed round, bringing the bucket again to the face of the excavation. (*Accepted December* 21, 1886).

HOISTING.

156. J. Wigham, Sunderland. An Improved Arrangement of Whipping Drum for Hoisting Coal, Grain, and like Material or Articles, and in Means for Regulating or Determining the Working Operations of Same. [8*d.* 1 *Fig.*] January 5, 1886.—The drum is loose, not keyed to the shaft, but operated by a friction clutch, and is provided with a collar at its outside end to prevent it moving with the clutch. (*Sealed January* 7, 1887).

12,234. Z. A. Szaniawsky, Zegrzyneck, Russia. A New or Improved Apparatus for Unloading Grain and other Substances from an Endless Belt. [6*d.* 2 *Figs.*] September 25, 1886.—This invention relates to a simplified contrivance for receiving grain at different places from endless belt transporters. For this purpose a roller is journalled on a displaceable carriage, so that it can be vertically displaced for permitting the upper part of the band or strap to be pressed down at the required place so as to cause the grain to fall into a shoot, which carries it off to the side. (*Sealed December* 31, 1886).

6474. J. Barrett, Eastburn, Yorks. Improvements in the Method of, and Apparatus for, Opening and Closing Doors in Connection with Hoists. [8*d.* 5 *Figs.*] May 14, 1886. The object of this invention is to construct apparatus by which the hoist doors on the various floors communicating with the hoist well, may be opened and closed automatically as the cage is ascending or descending the well. The illustration shows the means employed for operating the hoist doors by a straight rack O secured at the top of the hoist well. The doors are made in two parts, the top, D, and bottom (not shown) portions being connected at each side by chains G which pass over pulleys mounted in suitable positions. The edges of the doors are grooved and work on slides secured at each side of the hoist. When the hoist cage is rising up the hoist well, the lower rack O will come into gear with the pinion P of the floor to which the cage is approaching, thereby causing the pinion and the barrel secured thereto to rotate, thus winding round the circumference of the latter the chain E by which the top portion D of the door is raised, the chains G allowing the bottom portion to descend at the same rate, so that by the time the cage is opposite the floor,



the doorway is fully open. If the cage is then allowed to descend, the pinion P will revolve in the opposite direction, or if the cage continues its ascent, the pinion will gear with the upper rack, and by it be turned in the opposite direction, thereby allowing the two portions of the door to close. (*Accepted January* 8, 1887).

MISCELLANEOUS.

15,133. L. K. Scott, London. Improvements in Glass Levels, both as Regards their Manufacture and Fitment. [8*d.* 6 *Figs.*] December 9, 1885.—According to this invention thin glass levels are rendered strong and serviceable by covering them with glass tubes to form a jacket. The levels are suspended by springs where they have to bear sudden shocks. (*Accepted November* 9, 1886).

15,689. H. Stockman, Hampton, Middlesex. Improvements in Concrete Mixing Machines. [8*d.* 2 *Figs.*] December 21, 1885.—The improved mixing machine consists of a case containing a series of cones or pyramids and funnels placed vertically over each other. The ingredients to be mixed are placed into the hopper at the top, and descend by gravitation to the apex of the uppermost pyramid, then spread out and fall into the first funnel, thence on to the second pyramid, and so on. (*Sealed December* 28, 1886).

313. R. Troitzsch, Charlottenburg, Germany. Improvements in the Treatment of Ropes and the like, and Composition therefor. [4*d.*] January 8, 1886.—According to this invention cordage is impregnated with wood tar to which from two to seven per cent. of paraffin at boiling temperature is added. A dry cordage is thus obtained which does not become brittle. (*Accepted November* 9, 1886).

412. F. Craven, Brighouse, and B. Sutcliffe, Clifton, Yorks. Improvements in Flexible Connections of Steam Presses. [8*d.* 2 *Figs.*] January 11, 1886.—This invention relates to the pipes which connect the steam supply and discharge pipes with the steam or press plates. A short length of india-rubber tubing is slipped on the end of the steam pipe so as to leave a short overhanging piece of tubing. The india-rubber tube is then covered with a layer of asbestos, which latter is wrapped round with woollen cloth. The overhanging length of the tubing is then turned back over the wrapping which is a non-conductor of heat, and over which the ends of the flexible connecting pipe are passed and secured. (*Sealed January* 18, 1887).

424. W. A. Carlyle, Birmingham. Improvements in Spindles of Polishing Lathes and other Spindles, Countershafts, Carriage Axles, and the like. [8*d.* 10 *Figs.*] January 11, 1886.—According to this invention, the spindles, shafts, axles, and the like, are made of tubular form closed at the ends so as to form internally an oil reservoir, and provided with inlet and outlet holes so that each article forms an oil reservoir in itself, and the use of separate lubricators and oil cups for lubricating their bearings are dispensed with. (*Sealed February* 1, 1887).

10,779. S. P. Blackburn, Boston, Mass., U.S.A. Improvement in Valves for Pumps and other Purposes. [8*d.* 3 *Figs.*] August 24, 1886.—This invention relates to a valve formed of soft material, which will replace india-rubber in places where it is subjected to the action of steam or gases. The body of the improved valve is made of any animal, vegetable, or mineral fibre, sewn, stitched, or rivetted together and inclosed in a strong canvas casing. (*Sealed January* 21, 1887).

12,077. J. R. Alsing, London. Improvements in the Construction of Triturating Cylinders. [6*d.* 4 *Figs.*] September 22, 1886.—Inventor claims a triturating cylinder having an interior lining composed of removable sections fastened by means of bolts and nuts secured from the exterior of the cylinder, and having a perfectly smooth interior grinding surface. (*Sealed December* 31, 1886).

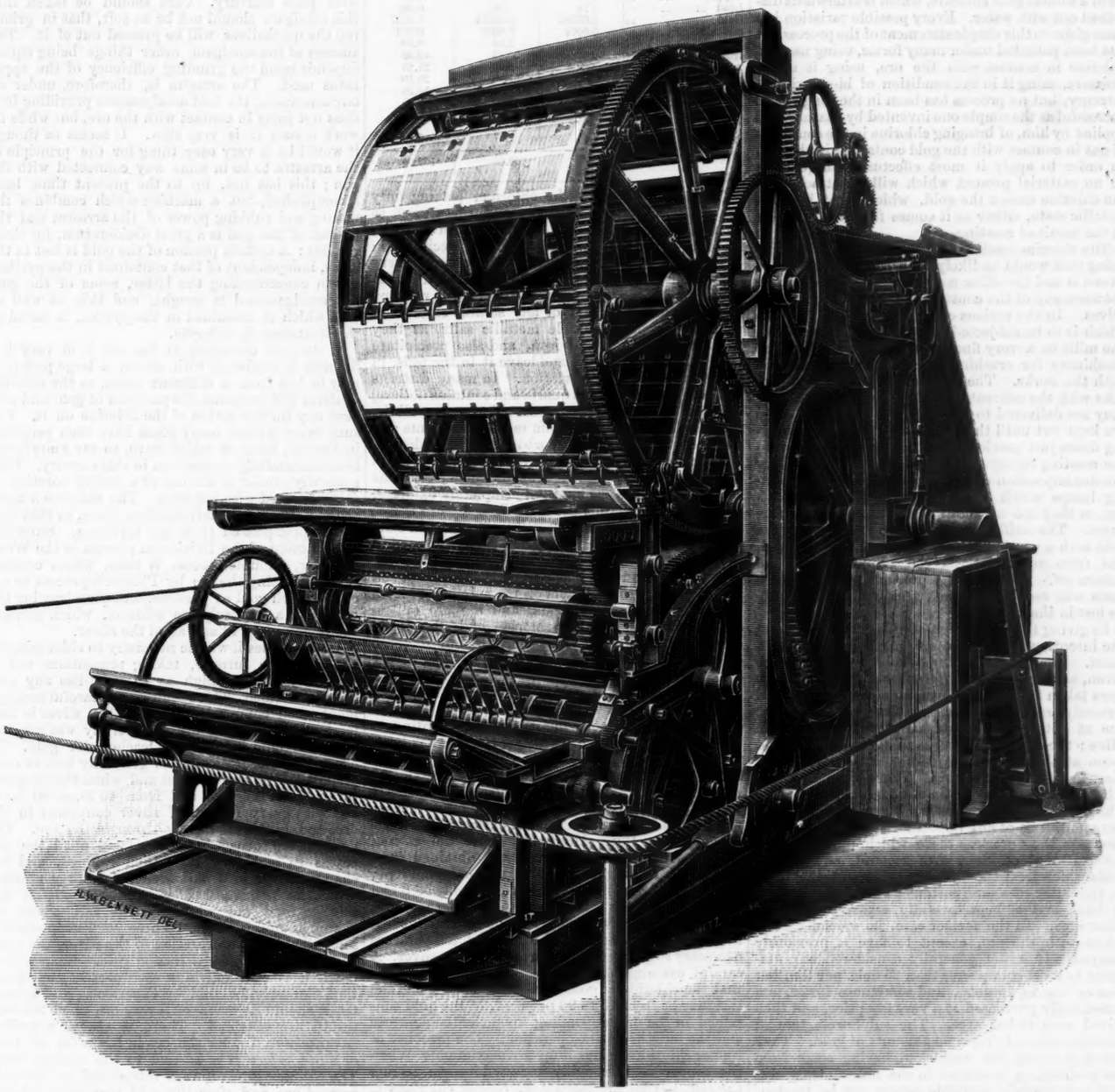
UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

THAMES COMMUNICATION.—The order for the construction of the two ferry steamers to ply between Millwall and Greenwich has been placed by the Greenwich Ferry Company with Mr. George Skelton, shipbuilder, of Millwall. These boats will be sufficiently large and powerful to convey 15 loaded wagons and above 1000 passengers across the river at every trip. As they will run about every ten minutes day and night they will supply a long-felt want in the east end of London. Mr. Skelton is also constructing an electric yacht 90 ft. by 11 ft. 6 in. by 5 ft., and a paddle steamer 88 ft. by 16 ft. by 5 ft. 6 in.

THE FEISTER BOOK PERFECTING MACHINE.

(*For Description, see Page* 200.)



LEACHING GOLD ORES CONTAINING SILVER.

By T. EGLESTON, Ph. D.

PLATNER'S process for the extraction of gold by chlorine gas was introduced into the United States in the year 1858 by Mr. G. F. Deetken, of Grass Valley, California, for the treatment of the concentrates from the various gold mines of that region. From its successful use in that place the process has been generally adopted in the other gold mining regions of California for the treatment of concentrates. Grass Valley has been for many years famous on account of the Eureka and Idaho gold mines, which with the other mines in its vicinity, have made it well known as a gold mining region. In this district there are many veins of quartz which are intersected by beds of both slate and granite ; a part of the gold is found in these veins as free milling, and a part of it is contained in pyrites which is found in and concentrated from the tails, after as much of the gold as possible has been separated by battery, blanket, plate, and sluice amalgamation.

The percentage of free gold in these various mines is extremely variable. In some of them, as the Idaho Mine, the largest proportion of the gold is free milling, while at many of the other mines in the vicinity the ores contain large quantities of sulphurets. In some instances they will amount to as much as from 7 to 10 per cent. of the total volume of the ore, while in others they will not be more than from 1½ to 2 per cent. Their value is generally from 40 dols. to 300 dols. to the ton. They consist mostly of iron pyrites, but as all that is heavy in the tails is caught, they may contain the sulphides of other metals if such are present in the ore, so that not infrequently they will contain copper pyrites, galena, and arseno-pyrite. When the ores of certain districts of both Colorado and California contain tellurium, this will be found in them and make them difficult to treat. The application of the Platner process is not prevented, however, unless the base metals other than iron are present in very large proportion.

The method of crushing the rock and of amalgamating the free gold and some of the methods of concentrating the tailings have been described.* Of all of these methods the use of the Fruer Vanner has of late years been one of the most successful. It has been very largely introduced in all the gold mines of the West. Every battery of five stamps is generally provided with one or two of these machines. When they were first erected it was supposed that one machine would be sufficient. It has been found, however, that there is a great saving in using two. In this case the ore is amalgamated in the battery and on copper plates before passing over the machines. There are very few ores upon which Platner's process can be applied directly. It is almost exclusively applicable in the United States to the gold, which is not free, and consequently is not

* ENGINEERING, vol. xxx., p. 395.

caught by the mercury in the various systems of amalgamation, and has become concentrated in the tails. There are, however, some ores and many concentrates to which the process cannot be applied.

The principle of Platner's process consists in attacking the gold in the ore by chlorine in order to form a soluble gold chloride, which is afterwards dissolved out with water. Every possible variation has been given to this simple statement of the process. It has been patented under many forms, using nascent chlorine in contact with the ore, using it under pressure, using it in the condition of bi-chloride of mercury, but no process has been in the long run so successful as the simple one invented by Platner, and applied by him, of bringing chlorine in the condition of gas in contact with the gold contained in the ore. In order to apply it most effectually there must be no material present which will be attacked by the chlorine except the gold, which must be in a metallic state, either as it comes from the mine, or as the result of roasting.

The chlorine itself must be purified from everything that would be likely to cause a reaction between it and the other constituents of the ore, or between any of the constituents of the ore themselves. In the various chlorination works the pulp which is to be subjected to treatment, comes from the mills in a very fine state of division, and no machinery for crushing ore is usually associated with the works. The only precaution necessary to take with the concentrates, as they are called, after they are delivered to the mill, is to see that they are kept wet until they are ready to go to the drying floors just previous to their introduction into the roasting furnace. If they are allowed to dry the decomposition of the pyrites commences, forming lumps which must be crushed before roasting, as they are not easily broken up in the furnaces. The oxidation of the iron may cover the gold with a coating, which is not readily removed, and from such material the sulphur is not all driven off. Some of the precious metal in such cases will not be attacked, and will consequently be lost in the tails.

In giving the description of this process it is not the intention to describe any particular establishment. The details for the whole process will be given, as they vary in different works. They have been taken from the chlorination works now and formerly existing in Amador County, California, one at Sutter Creek, and another at the Lincoln Mine; the Union Hill works in Grass Valley, and those at the Providence Mine, in Nevada City, Nevada County, California. There were formerly a large number of works in and about Grass Valley which have been abandoned. Many of them were too small to be of any importance. There are two classes of these works—those which purchase ores for treatment on their own account, and custom mills which treat them for the owners of the ores. In the latter case each customer's ore is put by itself in bins, and is kept carefully separate from the other ores. In the former case, no special care is taken with the ore, except to have it previously assayed. It is not generally considered advantageous to treat ores poorer than 25 dols. per ton, but ores as low as 15 dols., and sometimes lower, are occasionally purchased at a very low price, and then mixed with richer ores. The sulphurets treated contain extremely variable amounts of gold. They are all in a very fine condition, having come from the preliminary treatment in the mills. Only ores with a completely insoluble gangue can be treated. Of these, all are not equally well suited to this process, for if the gold should be in coarse particles the action of the chlorine would be so slow, acting only from the outside, that it would take too long a time to convert it all into chloride, and the process would become impracticable. For this reason ores containing coarse gold cannot be well treated by the chlorination process. As all the ores are sulphurets the process consists of four different phases:

1. Roasting the ore.
2. Impregnating the roasted ore with chlorine.
3. Leaching the impregnated ore.
4. Precipitating and fusing the gold.

1. *Roasting the Ore.*—The tails from the amalgamation mills are composed for the most part of the combinations of gold and silver with sulphur, arsenic, iron, or copper. The average composition of the tails is given in the next column.*

The object of the roasting is to convert all the metals, except the gold, into oxides, so that they will not be attacked by the chlorine, leaving only the gold to be acted on. The impurities most to be avoided are, sulphur, antimony, and arsenic, since their presence would cause the precipitation of the gold. Lead, lime, and magnesia are very deleterious, as they are likely to be attacked by the chlorine. It is also necessary during the roasting to avoid the production of any soluble chloride of iron or any other soluble metallic salts, as they will act on the oxide of iron, and also precipitate the gold once dissolved, and leave it in the tails, in the ore tanks, after lixiviation. In many districts the gangue of the ore is quartz and contains nothing which would be acted on by the chlorine, but all the rocks in Grass Valley contain more or less lime and magnesia, and therefore absorb more or less chlorine. In order to counteract this, as far as possible, a small amount of salt is added towards the close of the roasting after the ore has been completely oxidised. This must be carefully done. When the ore is free from impurities in contact with the air and salt, sulphurous and then sulphuric acid are formed in the furnace, which act on the soda, and set the chloride free, and this acts upon the gold. When lead is present the salt acts on the sulphate of lead, producing sulphate of soda, and a more or less soluble chloride, and oxy-chloride of lead. If the salt were not added these chlorides and the oxy-chlorides would be formed at the expense of the chlorine.

Analyses of Tailings.

	Eureka and Idaho Mines, Grass Valley.	Washington Mine, Maripoza County.	Black Bear Mine, Klamath County.
Copper	0.85	0.00	0.00
Lead	0.78	1.50	0.00
Gold	0.02743	0.00914	0.0137
Silver	0.0068	0.0035	0.003
Zinc	0.00	1.34	0.00
Iron	40.65	30.85	42.05
Arsenic	trace	0.00	21.25
Sulphur	32.80	31.33	25.10
Silica	12.64	33.30	10.35
Alumina	0.10	0.00	0.85
Magnesia	3.50	0.00	0.00
Oxygen and loss by difference	8.65	1.67	0.38
	100.00	100.00	100.00

The extraction of gold by amalgamation from gold-bearing silver ores has always been very incomplete, and is more unsatisfactory according to the length of time during which the ore has been roasted and is worse the higher the heat. In the Murphy Mill, Ophir Cañon, Nevada,* where the ore was roasted in a reverberatory furnace, the efficiency was only 25 per cent. When a Stetefeldt furnace was used about 80 per cent. was extracted. At the Alice Mine, Bute, Montana, where the Howell furnace was used, the percentage obtained from January 1 to August 6, 1879, was only 55.6 per cent. At the Lexington Mill, in 1882, only 58.8 and 60.8 per cent. was extracted. As all of these ores contained some silver, there is no doubt that the loss in gold was occasioned by the elevated temperature necessary to get a high chloruration for the silver. A careful examination made of this subject showed that the chloride of gold is in itself volatile, and the loss may be from 40 to 90 per cent. of the gold contained in the ore, depending upon the temperature and the length of the operation. The presence of copper chlorides brings it up to a maximum.† When the copper is thoroughly oxidised before adding the salt, so that the amount of copper chlorides is reduced to a minimum, the loss is very much less. There is every reason, however, why the salt should not be added until after a thorough oxidation of the ore so as to prevent the formation of copper chlorides.

As the results of recent experiments it appears that gold ores which must be roasted should be roasted as quickly as possible, and that probably the Stetefeldt furnace will answer better than any other for that purpose; that copper, if it contains amalgam even in very small quantities, prevents the amalgamation of the gold; that lead acts still more injuriously, hence the reason why amalgamation in the arrastra, where no iron is exposed, gives far better results than if the process had been conducted by pan amalgamation; that copper as sulphate may be present in the ore as it is in the arrastra without affecting the results; that amalgamation of very finely divided gold requires precaution; and that contact with the quicksilver alone is not sufficient. There is no doubt that quicksilver when very liquid does not readily take up gold, and that it is desirable to amalgamate with gold amalgam if that is possible, and if not with silver amalgam where gold amalgam cannot be had, instead of with pure mercury. Care should be taken that this amalgam should not be so soft, that in grinding the quicksilver will be pressed out of it. The success of the amalgam, other things being equal, depends upon the grinding efficiency of the apparatus used. The arrastra is, therefore, under all circumstances, the best amalgamator providing iron does not come in contact with the ore, but while its work is sure it is very slow. It seems as though it would be a very easy thing for the principle of the arrastra to be in some way connected with the pan; this has not, up to the present time, been accomplished, but a machine which combines the mixing and rubbing power of the arrastra and the output of the pan is a great desideratum, for these reasons: A certain portion of the gold is lost in the mills, independent of that contained in the pyrites; but in concentrating the latter, some of the gold not amalgamated is caught, and this, as well as that which is contained in the pyrites, is saved in the treatment by chlorine.

If the gold contained in the ore is of very low fineness or combined with silver, a large part of it may be lost from a different cause, as the chloride of silver will surround the particles of gold and prevent any further action of the chlorine on it. For such cases as these many plans have been proposed in Europe, none of which have, to my knowledge, been successfully carried out in this country. They generally consist in the use of a strong solution of salt saturated with chlorine. The chlorine attacks the metals, and the salt dissolves them, so that they can be precipitated from the solutions. Since the introduction of the lixiviation process in the West, however, a double process is used, which consists first in treating the ore by Platner's process to get out as much gold as possible, and then treating the tails with a hyposulphite solution, which extracts the remaining gold and all of the silver.

In such cases it will be necessary to chlorurise the silver in the furnace, taking precautions not to raise the heat so high as to volatilise any gold chloride formed. This requires very careful management when copper is present. The silver is then leached, the leached ore is carefully washed, and the tails chlorinated and leached for gold. To effect the chloruration, it is generally best to completely oxidise the ore first and when the temperature is quite high to add from 40 lb. to 50 lb. of salt with every 100 oz. of silver contained in the ore, and rabble it entirely through the ore. The doors of the furnace are then closed until the salt ceases to crackle. It is then rabbled, and the charge drawn in from twenty to thirty minutes after the introduction of the salt. It is not safe to add the whole of the salt when the charge of ore is made. Three or four pounds of salt will aid the chloruration of the silver, but more will be apt to cause a loss in gold. Exactly how much it is best to add in each part of the operation can only be told by experience, and careful trials should be made on every ore until the best results are obtained. There is always a decided advantage in leaving the ore in heaps for an hour or more before it is carried to the cooling floor. The chlorine gas is always introduced on the cold roasted ore, and after the gold is washed out, the calcium hyposulphite solutions are used to leach out the silver. It is not necessary with ordinary ores to discharge the tub for this purpose, though it must be when the ore contains much lead. The launders used for the two solutions should be separate and the reception vats at opposite extremities of the line of tubs. It is not necessary that the extraction of the gold should be complete, as the calcium hyposulphite will dissolve what remains behind in the silver.* When there is a large quantity of lead present the roasted ore is washed clean with water to remove the soluble chlorides and then leached for silver. The leached ore is then removed from the vat, dried until it is as moist as is required for chlorination, chlorinated and leached, and if it is still rich in silver, treated again with a hyposulphite solution.

The roasting of these ores, as they are all fine, is usually effected in some kind of reverberatory fur-

* Mineral Resources of United States West of Rocky Mountains, 1872, page 337.

* *Engineering and Mining Journal*, vol. xxxiv., page 257.

† Transac. Inst. Mining Engineers, September, 1885.

* Transactions American Institute of Mining Engineers, vol. xii., p. 41.

nace built of common brick. All the different kinds of mechanical furnaces have been proposed for this purpose, and have been used in other countries, but they have not, so far as I know, been used to any great extent in the United States, though there does not seem to be any reason why they should not be, except that the limited capacity of the works does not usually justify the erection of furnaces where steam engines have to be used, when the work can be done by men. If the quantity of ore to be treated were very large, there is no doubt but that the use of a mechanical furnace would be much more advantageous than that of a reverberatory furnace. Three different kinds of the latter furnace are used, which vary only in the disposition of the hearths. The hearth may be single and short. A series of hearths may be placed one over the other, the hearths may be single and long, and in the same plane, or they may be arranged in steps. The first variety is wasteful of fuel, and there is always danger that the ore will be sintered in it. The second, however arranged, although economical in fuel, is inconvenient. Whenever it is used the doors should be on opposite sides of the furnace and the ground at such a level that they can always be reached. When the doors are on the same side of the furnace, and are reached by platforms, these are always in the way. The third and fourth varieties are on the same general principle, and are the most economical. The fourth is a little more expensive to build; but there is a great gain in keeping the ore in the different stages of roasting on different hearths, and then dropping it from one hearth to the other, but the chimneys should be so arranged that there would be no danger of fresh or unfinished ore dropping on to the hearths below. Both of these furnaces are much in use in California, and are very advantageous both in economy of fuel and labour. At Sutter Creek the furnace is a *Fortschaufellungsofen*, the hearth is 12 ft. wide and 80 ft. long, inclined from the flue towards the fireplace without any break. It has twelve doors in the side for working the charge, and is capable of working three charges of 2400 lb. to 2600 lb. in twenty-four hours. The distribution of the charges on this hearth, however, is, as if the furnace contained three charges, which are kept separate with the very greatest care. The one nearest the flue, where the ore is quite cool, is used for drying. The middle hearth is used for burning off the greater part of the sulphur, and here the ore is spread out very thin and is constantly rabbled. The last hearth nearest the fireplace is at as high a temperature as it is possible to raise the ore, without sintering it, and here a dead roast is effected. If the temperature should be so high that any of the ore became sintered it would have to be re-crushed and re-roasted. It may be said, in general, that the smaller the charge treated the better the work will be done, so that it is usual to limit the charge on each hearth to from 2800 lb. to 4000 lb. It is also essential that in moving the charges from one hearth to another they do not become mixed, as that lengthens the working considerably. A very low heat is required on the upper hearth, especially if the ore contains lead. The colour of the heat should be a dark red when the ore is stirred, but black on the surface in the daytime; at night it shows a dull red. Constant rabbling on this hearth is not necessary, but the ore should be moved from time to time when the upper surface becomes dull; towards the end only should the temperature be high. Tests can then be made to ascertain whether all the iron and copper sulphate has been decomposed, but generally this is not done, as the men know by experience when the ore is finished. If any amount of copper is present a high heat is required to decompose the copper sulphate. In some works the finished charge is panned to get the colour of pure gold and to see whether there are any decomposed pyrites present, but this is not usual.

(*To be continued.*)

THE NATURAL HISTORY OF LOCAL BOARDS.

IV.—THE EXPERIMENTAL BOARD.

(*Concluded from page* 176.)

THESE pleasant recreations beguiled the tedium of local government in Oldhards for at least a couple of years, without perceptible progress; for, as heat in water raises steam, so heat imported into business engenders volumes of cloudy and windy vapour, which, uncontrolled and undirected, usually dissolve into thin air and leave nothing behind. The death of their most formidable adversary had given the members a long breathing space in their inevitable march towards Chancery, as we have seen; and even when the action was recommenced by his executors, and the injunction issued as a matter of course, time was granted to see what they meant to do. Plaints and petitions rained in from all sections of their distressed district, groaning terribly under the plague of scarlet and typhoid fever. In a single epidemic occurring in the latter part of 1880 and the beginning of the following year, eighty deaths occurred from the former disease alone. For a considerable part of this time there was no nuisance inspector. Two schools were closed by the orders of the Local Government Board, lest the children should carry poison to one another during another outbreak of fever. A joint meeting of local authorities was held, at which Oldhards and three other fever-stricken districts were represented; and something was projected by way of a fever hospital. But as the fever abated so did their enthusiasm, and nothing came of it. For the fourth time in succession, tenders were invited for emptying ashpits, and were allowed to lie on the table. Ratepayers' petitions were fought over and laid on the table. The water supply fell short, leakages broke out in the rising main, and some parts of the district were left to the tender mercies of the owners, who thought the drainage of a manured field ample provision for their hapless tenants. People were seen at ten at night catching the water which trickled out of the end of a field-drain at the rate of two buckets per hour—people who had come early in the afternoon.

The Local Government Board, sick of this *enfant terrible* amongst their not very docile subjects, sent down a copy of a memorial from certain ratepayers, alleging default in the construction of sewers. This, too, was laid upon the groaning table, while the Board fought their battles, not against the common enemies, disease, filth, and immorality, but against each other. To mend matters, the Liberal caucus, in their anxiety to secure unanimity and friendship, selected the candidates for election on political grounds, denouncing the chairman—who was a Tory—in that he shirked the drainage question; a charge which, in spite of the political animus which directed it, seemed clear upon the face of the evidence. But notwithstanding Caucus, Local Board, and Local Government Board, and the two "grand" theatres this squalid mining village now boasted, its wretched inhabitants prayed aloud in their misery, and many of them, despite their good pay and constant work, might well have envied the naked savage who could breathe the fresh air of the desert, and quench his thirst at the pure mountain spring.

Eighteen months after the authorities had sanctioned the Board's new scheme of drainage, they asked leave to postpone the least urgent part of it and carry out the rest, and so relieve the district, in which the scarlet and typhoid, and, worst of all, the putrid diphtheria, were levying their hideous tithes for the fat churchyard. Wearied of continual pursuit, the Local Government granted this; yet still insisting that the whole was necessary. But even this step was arrested by the abatement of the fever; until, after another year's delay, the Chancery injunction was granted, and six months' respite given for a scheme to be carried out. Goaded by this, and by 'savage' letters of inquiry from Whitehall, the Board changed their front, and secured another delay by again shifting their point of outfall, and applying for borrowing powers in accordance therewith, making the fourth or fifth application for purposes identically the same. Again, precipitation or settlement, with land filtration, was to be the process. The clerk's position as engineer was attacked at the inquiry; but the inspector wisely declined to deal with the question. A month's adjournment was the result, to give the Board time to consider whether or not to consolidate the outfalls into one at the "Common."

But finally the Board put down their foot and decided to go on with the last scheme, only increasing their estimate so as to include more land and heavier works in preparing it. Indeed, it was not very promising material they had to deal with, being graphically described by their own engineer as a yellow clay with a blue bind (or shale) below it; but, for that very reason, it formed a fine field for the genius of an Experimental Board. Many thousand cubic yards of this stuff were to be burnt to make it porous; which mystified one member of the Board, who could not see how there should have been an old burning process to make the reservoir tight, and now a new burning process to make the sewage land porous. Then 6000 or 7000 square yards of land were to be raised 6 ft. with carted material. The inspector challenged the estimate and the limited area of land, committing himself to the proposition that 20 acres would be required for 8000 people to avoid chemical treatment. This produced other changes which led first to an agreement for the purchase of 13½ acres of land from their old adversary, and then, after another look at the question, to the prompt repudiation of the same, and the substitution of compulsory powers to purchase four acres. The indignant owner sought in the High Court of Justice to restrain them from making application for a provisional order for this purpose, and succeeded; but the appeal was followed by another trial, and the comedy-at-law ended in the triumph of the policy of repudiation on some technical point. So the application went forward, and was opposed by the defeated party, who wished to force the 13½ acres into the scheme. At the inquiry, the question turned upon the levels, and the inspector, being satisfied that the larger area was incompatible with level of the sewer outfall, decided in favour of the Board, who effectually made it clear to the world that after their ten years' deliberation they had at last signed and sealed an agreement to buy a plot of land, nine acres of which would have required lowering three or more feet for sewage treatment; an act now cancelled by their bold policy of repudiation.

But we must get on with our difficult task of tracing the complications of an Experimental Board, attempting less that we may accomplish more. A cloud of threats, suits, checks, quarrels, and "lively scenes" must be passed over; besides despairing plaints and petitions from below; bitter cries falling on stony ears, and now resounding on memory's ear like a Greek chorus, giving the doleful burthen to the play. And the reader must fancy—if indeed his fancy can stretch so far—the new scheme actually commenced; all papers, figures, estimates, parleyings, and pen-and-ink chaos set aside for a time, and substituted by the honest dirt-cleaving spade and pick, which so long had been hungering for their work. Let him imagine the pipe contracts let, and the clerk-engineer demanding his fireclay pipe-testing machine as a *sine quâ non!* while the excavator is at work cutting the straight grooves, and driving his short headings above those dangerous coal-workings far down below, whose creeps and settlements already were credited with having broken the levels of the old sewers. He may also imagine the usual debate as to why a clerk of works should be appointed, at the Board's cost, and how the Board, at last growing tired of experiments, stopped short of adding a fourth to the clerk's many parts, and declined to endow him with 2*l.* a week to hire a dummy inspector, whose place would be filled by himself and his son.

Another opinion had been got on the vexed question of the clerk-engineer, and this time a favourable one, which settled the legal aspect of that matter. But another aspect cropped up, tenfold more formidable in the issues involved. In the common relations of clerk, surveyor, and engineer, boards have a balance of power of the most salutary kind, independent of the ability with which the offices may be filled under the separate and triune methods respectively. The clerk advises on the duties and powers of the surveyor as laid down in the Public Health Act, and though the engineer's duties are not defined by any written law, he—the clerk—conducts all the correspondence, enters the minutes, draws up all resolutions and forms of appointment, and prepares and executes all agreements and contracts with the engineer and with those over whom he wields an almost arbitrary power. He is the channel of all petitions and complaints, the instrument of payment, keeps all scores, and should at a glance be able to produce the letter of the law, the minute of instruction, and the precise state of the account as between Board and contractor, or Board and engineer. But if this balance of power do not exist, and, as in the case of our Experimental Board, one man fills all three departments, a Board must speedily find themselves in the presence of a superior power, so long as they see fit to tolerate it. Like a despotic ruler, he is king, lords, and commons—the three estates rolled into one—under the shield of a parliamentary form. At Board meet-

PROJECTED HARBOUR WORKS AT LISBON.

(*For Description, see Page* 201.)

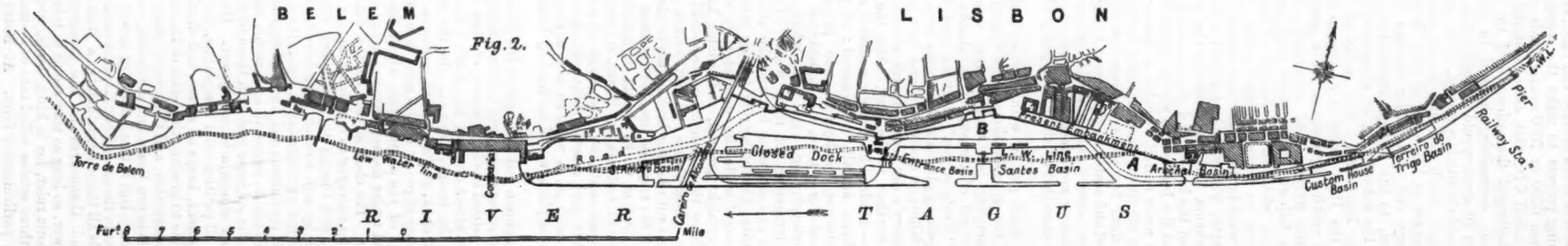


Fig. 2.

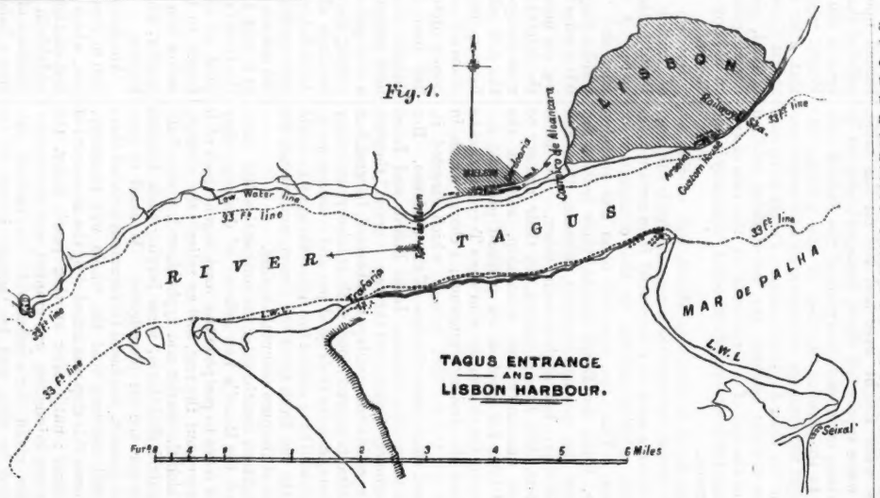


Fig. 1.

ings he speaks with three voices, not one, and only the nicest skill can detect the true quality of each. If the clerk be at fault, the engineer helps him out; if the engineer go astray, he has a wily defender at his right hand to cover his erring footsteps, one who is not to be bribed nor intimidated, and should the surveyor's curiously short limits of duty be questioned, two trusty advocates silence his enemies. Then the Board, with no one to advise them against their three-headed tyrant, are outnumbered, get bothered and mystified, and, losing their heads, are, for a time, as tenderly led by the nose as asses are. Even so it fell out with our Board, who now found they had embarked upon an adventure as stormy and hazardous as any of their ill-starred experiments. Even the economy of the thing did not quite fit to their modest ideas, and extra after extra opened their eyes; some of them justifiable indeed, but none the less disliked and disputed. The township roads were worse than ever; where was the surveyor? The books fell into arrear; where was the clerk? The contractors were waiting for plans; where was the engineer? At last the best friends of the three officials declared that he was too much engaged in other ways, and left the Board's business to itself, suggesting an underground current which was carrying off much of his energies into matters quite foreign to his public duties. A general election took place, when lo! this much-endured man found time, in the interstices of his three-man part, to act as electioneering agent against his staunchest supporters; and what was worse, as a successful one. This was the keenest thrust of all, and speedily the majority was shifted to the opposition.

The contractor lodged a formal complaint that he could get no tracings of the plans whose lines and levels he had bound himself to follow; whereupon the clerk told the Board that he could have them by paying for them. This cool proposition staggered them. Extra charges then appeared for time-keeping and superintendence, which the clerk distinguished from ordinary engineering superintendence with the adroitness of a Jesuit schoolman. At last ugly rumours got abroad as to works now going on, and the Board insisted upon knowing how things stood, overruling the clerk's objections and menaces, and calling in the clerk of works, with whom they conferred *in camerâ*. Then the contractor said the works would not act; the medical officer laid aside his dignity and his coat, and followed the stern path of duty by descending into the suspected sewer and making experiments; as a result of which he denounced the levels incontinently. Other clouds arose and filled the gloomy air. A third Chancery suit was threatened for pollution of streams, and the answer to this new charge was stigmatised as not only unsatisfactory but intolerable; while the long-suffering people at Whitehall well-nigh exhausted their inspectors in trying to get this unlicked cub of sanitation into shape; one of the inspectors about this time made a special report on the truly dreadful state of Oldhards under a new visitation of fever and diphtheria.

Driven at bay, the clerk showed all his commanding power of defence. He began to hint that the colliery workings were not free from blame in respect of the queer levels of the new sewer; at which the coalowners bridled in alarm, and asked for leave to take copies of the plans and sections; and one firm, with a fine perception of the art of 'hedging,' brought the very handsome claim of 5000*l.* against the Board for alleged damage (actual and prospective) to their surface property and their mines by the sewage works. These were the same owners who ten years before had been charged with lowering the roads; a charge, by the way, which had been mysteriously dropped. The impeachment of these great men filled the cup; and at last the Board, brushing aside all sophistries, did that which they should have done a dozen years before—calling in an experienced hydraulic engineer of high standing to report on the design and construction of the new works. But this was not done without a strenuous resistance from the three-man power; in which the clerk, who had hitherto offered a gallant defence, made a fatal error.

Instead of himself anticipating the inevitable conclusion, and proposing the appointment of an engineer to settle all doubts, he stubbornly opposed it with all his might; bringing his three-man power to bear at every line of defence. First, the clerk helped him by assuring the Board that the calling in of any other engineer must be preceded by the rescinding of the resolution appointing himself as engineer, which resolution provided three months' notice of resignation or dismissal; whereupon his adversaries were at a loss to find the right resolution amongst a maze of similar ones; and the puzzled majority were tossed to and fro in a sea of irregular notices of motion, informal meetings, and illegal resolutions, in which sport a determined minority was turned to excellent account. Then the surveyor said that no man should break into his roads for purposes of sewer inspection; and both clerk and surveyer were backed up by the engineer, who swore he would not part with his plans and sections until his engagement was finished; neither would he permit any man, even by resolution of the Board, to open into the sewers now under contract; which indeed, he said, might be construed by the contractor into their taking possession and releasing him from responsibility! So far as the records can be made out, he did not forbid the consulting engineer to walk along the Queen's highway in Oldhards.

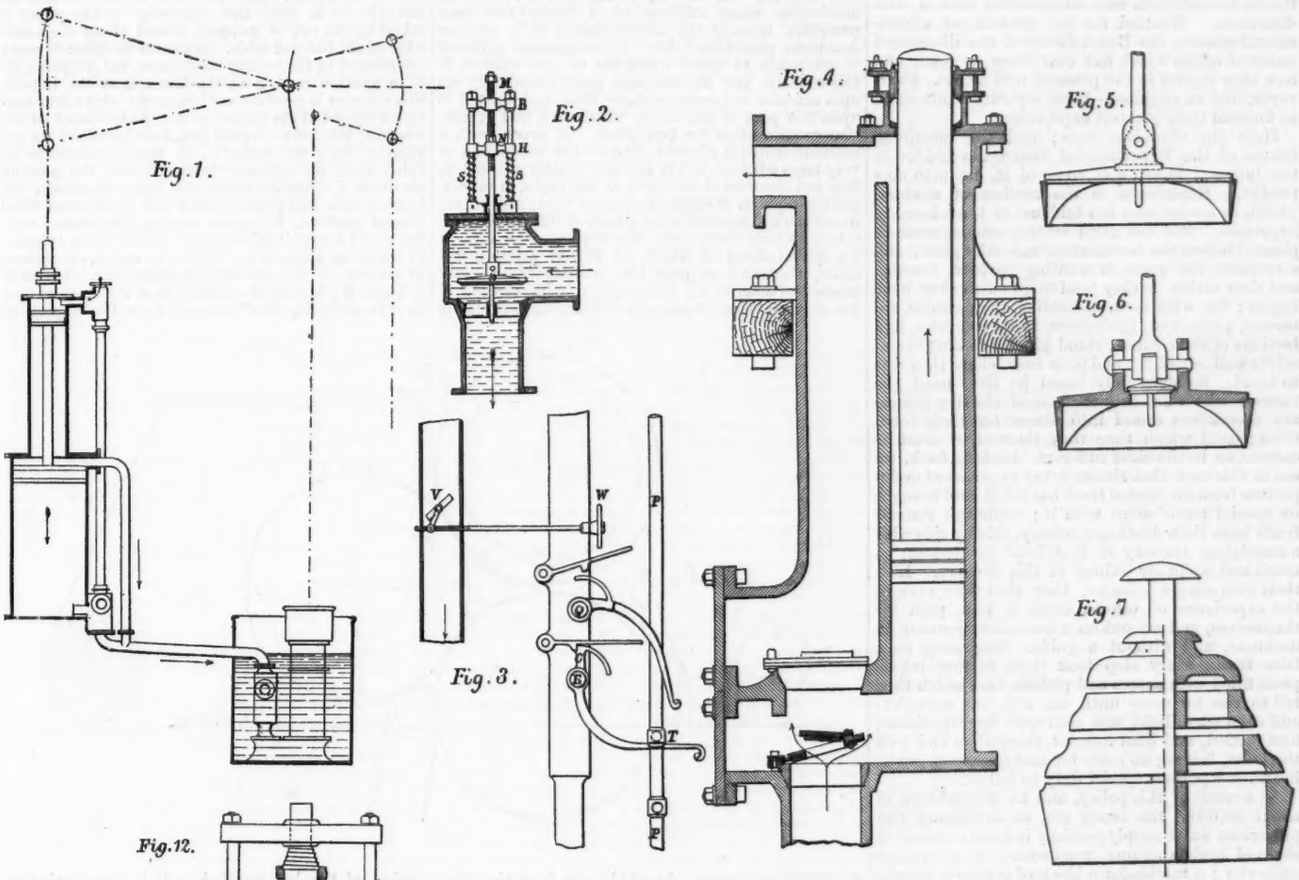
On a similar occasion, when a Forcible Board was set at defiance, we have recorded that they dealt with a contumacious clerk by holding a meeting in the street and dismissing him there and then; and when he detained their books, by haling him before the justices, who gave him seven days to determine whether he would yield or go to prison. This was a mode of action worthy of a forcible race known to all the country-side as the "Bleak-heights Bulldogs." But the Experimental Board lacked gall to make bitterness. Their force exhaled in a Babel of sounds, and their offensive operations were painful, tedious, and erratic as the steps of a paralytic. But it may be that old friendship and respect sapped their resolution in some degree. So they sought present refuge in a Local Government Inquiry, at which the engineer's interests were—for a moment—served by the clerk in so far that the notices were so manipulated that it was alleged that practically the inquiry was a pleasant and agreeable conversation between the engineer and the inspector; and the majority seemed to get no further from the latter's report, but rather to recede, for by a stroke of finesse, and a threat of resignation, a vote of confidence was passed to the engineer, who having achieved this signal victory, straightway gave notice of resigning his engineering appointment.

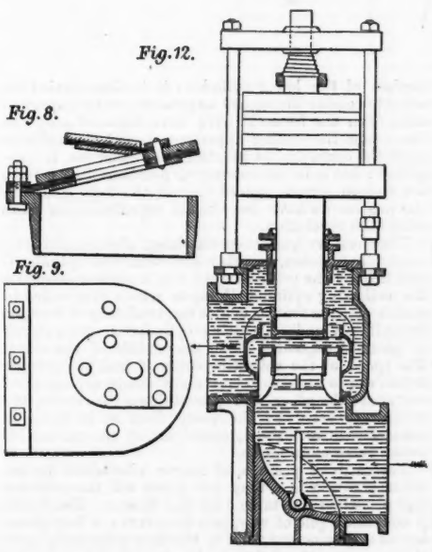
But the finesse and victory were barren. The annual election took place, and the trinity of officials found a united Board against him, all his friends being thrown at the bottom of the poll. At the very first meeting it was decided to call in a consulting engineer, and speedily the

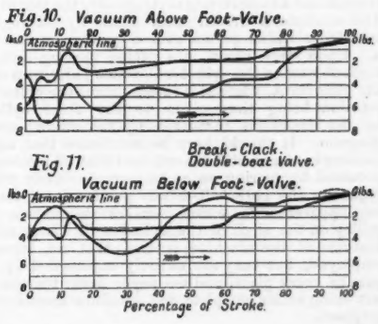
PUMPING ENGINE AT THE LINCOLN WATER WORKS.

MR. HENRY TEAGUE, ENGINEER.

(*For Description, see Page* 200.)







thing was done; and now, for the first time in its history, the eye of experience and competence was brought to bear upon the sanitary needs of their district. He encountered all the devices of obstruction as to plans, openings in sewers, &c., for this "master of trinity," losing his head, declined to produce a single paper or plan. But the deposited copies at Whitehall were available, and all difficulties being overcome, the engineer made his report.

He found one of the sewers in practical accordance with the plans, but could not report on the outfall works for want of the details. But with respect to the last section now being drained, he found serious discrepancies; the surface and invert being out of truth to the extent of from 2 ft. to 5 ft. The outfall was 2 ft. too low, so that without levelling the land to at least this extent, it would be impossible to utilise its yellow clay and blue shale. Gradients were halved, and the fall sometimes went the wrong way. Nearly a hundred houses ought to be, but would not be, served by this drain; while a close of land, which had been bought and surveyed after many a stiff debate, had only one-half its area available for sewage, and even that lay too near the town for safe use. To fill up the catalogue of ills, a storm-overflow of curious construction was pronounced to be useless; and, while in the very act of digesting this gloomy report, another Local Government inspector, whether the tenth or the twentieth it is impossible to say, visited the district as a beacon to warn them of the approach of the cholera, and harangued the Board on their sanitary obliquity in general.

The end was near. The courage of passion was roused within the Board, and by a supreme effort of resolution, the clerk was asked to resign all his offices; which accordingly he did, but in his own way, stipulating that the chairman should sign a testimonial already drafted by his own hand, and immediately withdrawing his resignation on the Board's refusal to accede to this novel condition. Then time was trifled in the vain discussion of legal notices of motion, dismissal, resignation, &c., face to face with their masterful servant, who treated them like dogs, blocking every adverse motion, and locking the whole machine of local government. Being asked to repair a certain road, he declined point-blank unless accorded an indemnity, for it was not a public road, and therefore the expense would be illegal; and no former illegality of the kind could render it otherwise.

The reader may now figure the poor motherless Board at the mercy of its own three-headed Cerberus and finding none; while from a heartless public they got derision instead of pity. The "Oldhards Pantomime," and its comic business, transformation scenes, burlesques, and mock heroics became part of the stock amusement of the world, and the whole travesty was aired weekly in the local press, until, goaded beyond endurance, the Board dismissed their master and ceased to be a laughing-stock. Relieved of their incubus, they breathed freely. But although vanquished, he fought upon his stumps with that dogged pluck which has led so many of his countrymen to fortune and high dignities. He impugned the legality of the resolution of dismissal, and flatly refused to deliver up the archives of the Board, defying his foes to the magisterial test; and such is the disturbing influence of fear on the judgment, that the chairman deemed it prudent to meet the fallen clerk on the battle-field under the shield of a man of law. Even when dismissed the old clerk appeared side by side with his temporary successor, still claiming the office.

At last, however, a summons to appear before the bench under the charge of wrongful detention of the Board's property acted like the magician's wand. The gas was turned off, the pantomime vanished, and stern reality took its place. Without the assistance of more than the law's shadow, the books and plans were surrendered with a wise discretion. Wearied for the present of experimental science, the Board divorced the ill-omened union of offices which had cost them so dear, and now they rejoice in the possession of a clerk, a surveyor, and an engineer—three separate wants—and so finished their greatest experiment.

Here our chronicle ends; and the remaining course of the Experimental Board lies hidden in the future. What will come of it, no man may predict. Experience is the mother of wisdom, which, as a wise man has told us, is the science of happiness. But the germ of this science must be planted before the fertilisation can take place, and sometimes the germ is wanting in local boards; and then rather do they tend to go on as they have begun; for wise men, beholding the passions, interests, prejudices, ignorances, incompetencies, and factions of their rulers, stand aloof, thinking themselves well out of it; and fools rush where they fear to tread. So does folly breed its like, until the masses, who constitute the base of elective power, are themselves raised into fitness for their functions; until which time they themselves must be content to be the chief sufferers. Looking back, we see in this case that almost every experiment or departure from the beaten track has failed, and brought its special punishment with it; while the general fruits have been death and misery, side by side with a scandalous travesty of that local government so much and so justly valued in this country. Like their own simple collector, they shut their eyes to the experience of others, chose a new path for themselves, and set out on a hazardous journey in darkness, and without a guide. Beginning on a false track, every step took them further into a place filled with snares and pitfalls, into which they fell to rise no more until the evil was wrought; and even when light was conveyed by experience, first faction, and then interest, stepped in and took the helm, leaving no room for that science of public health it was their special duty to follow.

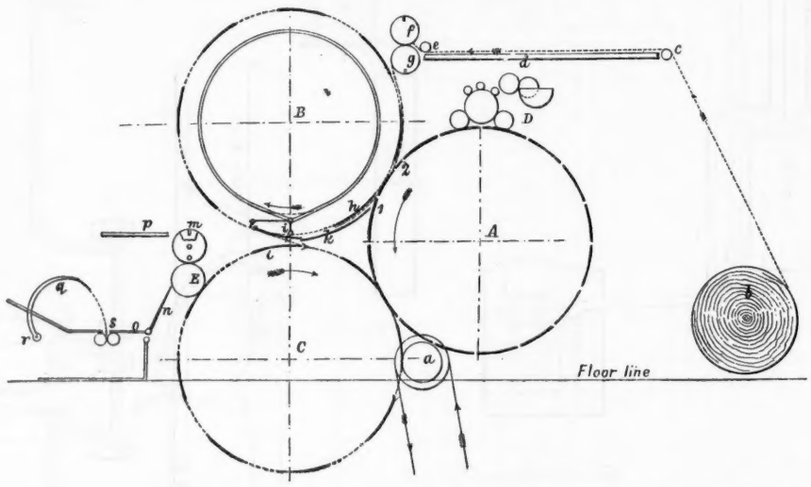
As a result of this policy, and an expenditure of about 30,000*l.*, the assets are, an indifferent and precarious water supply partially in force; a tangled skein of broken drains, condemned by competent authority; a tumbledown block of cottages, bought for alteration into a board-room, and set aside by the Local Government Board; some meagre road improvements and public lighting; and a wilderness of swampy roads which, in the old farming days, were hard turnpikes with a clean face.

The debit side can never be cancelled; for even the oscillations of the Experimental Board were not much more frequent than those of the wings of the angel of death as they beat over the rotten places of their fever-wasted district. A single epidemic of scarlet fever carried off, as we have seen, no less than eighty victims. In one year, 1884, the death-rate rose to 30 per 1000, thirty-four of whom were stifled by diphtheria, in a straggling district with the green fields and woods on every side; while the average of fifteen years since the Board was formed has been 21 per 1000.

Finally, in the unique venture of their clerk-surveyor-engineer, the experiment, promising at first, proved a signal failure. They put all their eggs into one basket, contrary to the adage; and at the same time proved the wisdom of another old saying which advises the shoemaker to stick to his last. Local governors cannot by resolution make engineers, and the skilful book-keeper had better leave sewers alone. A trained engineer may fail, though cheap; but after all, an engineer is the best man to do engineer's work. A fire may burn us, but without fire we cannot boil our potatoes.

FEISTER'S BOOK PERFECTING MACHINE.

In these days of keen competition and gratuitous distribution in enormous quantities of advertising circulars and pamphlets, cheapness of production is a first necessity both to the printer who secures the contract, and the manufacturer who makes his goods known to the public in this manner, and often on a gigantic scale. This method of advertising is the outcome of American rather than of English enterprise, and therefore naturally printing machinery especially adapted for rapid and cheap production of work of sufficiently good quality to suit the purpose, is mainly of American design. The Feister Press Company of Philadelphia take the lead in this branch of industry, and the Feister book perfecting machine is altogether a very remarkable and efficient piece of mechanism. An outcome of the company named, is the Feister Printing Company, which amongst other business is now engaged in working off an enormous edition numbering many millions of a thirty-two page pamphlet forming the advertisement of a popular American patent medicine. Circumstances rendered it advisable to print 8,000,000 of the edition in this country, and the company have accordingly set up a machine in London at Snow Hill, and started it upon this part of the work, which will find it continuous occupation for two years. Of course such a machine as this is adapted only for the production of very large editions, but it appears equally adapted to turn out circulars of one, two, or four pages, or to complete pamphlets of eight, sixteen, or thirty-two pages, its maximum capacity being a book of 128 pages small octavo at each revolution. Having given an idea of the special object for which the Feister printing machine, illustrated on page 195, is designed, we may proceed to describe its arrangement, with the aid of the accompanying diagram, that illustrates very clearly its general principles. As will be seen from the illustration, the main features of the machine are the three large cylinders A, B, and C, each about 6 ft. in diameter and 3 ft. in width. These cylinders are open-framed, and a toothed ring is attached to the side of each. The machine is driven from below by an engine, a belt from which passes over a pulley on the shaft *a*. Upon this shaft is a pinion gearing into the toothed ring on the cylinder C, which in its turn drives the cylinder A, while this latter drives the cylinder B, rotation being thus given to the three cylinders in the directions indicated by the arrows on the diagram. It should here be mentioned that all the gearing in the machine is cut, and that all motions are obtained by gearing, so as to give absolutely reliable register; the only belt-driven portion being the inking apparatus D, which receives its motion off a pulley on the shaft of the cylinder B. A prominent feature of the machine is also that no tapes are employed, but they are entirely superseded by grippers in every place, and the paper never travels without being under complete and absolute control of the grippers.



The formes are mounted on the cylinder A in a direction parallel to its axis; they are either stereotypes or electrotypes, sixteen in number and curved slightly to the same radius as that of the cylinders. These formes are each 3 ft. long and 14 in. wide, and in the case of the special work now being done at Snow Hill each forme comprises eight pages, so that 128 printed pages are turned out at each complete revolution. But of course the sizes and arrangement of the pages may be modified in any desired manner. As will be seen in the diagram, the stereotyped formes are mounted close together around the circumference of the cylinder A, but the surfaces carrying the blankets on cylinders B and C, and on which the paper receives its printed impressions, are spaced somewhat widely apart. Having described the main features of the machine, we may follow the action of the cylinders through a complete revolution. The paper used is delivered in continuous rolls about 3 ft. wide. Passing from the roll *b* it travels over a guide roller *c*, on the top of the table *d*, under a second guide roller *e*, and then between two cylinders *f* and *g*, the upper one of which is provided with a cutting device consisting of a saw working with a longitudinal slot in the cylinder, a strip of wood being inserted in a longitudinal groove in the lower cylinder for the saw teeth to bear on when they come into operation upon the paper as it passes between them. Before being cut, however, so much of the paper as is required to form a sheet has been fed out by the cutting rollers on to one of the blankets on the cylinder B, until the outer edge of the paper is seized by the row of grippers placed along the lower edge of the blanket table. As soon as the piece of paper is separated by the cutting mechanism, the grippers hold it in position resting on the blanket, as the impression cylinder B revolves and brings the sheet into contact with one of the formes on A. As indicated on the diagram, the sheet *h* would just have received its impression from the forme 1. It then continues to revolve until the cylinder brings it into the position shown at *i*, when by means of a cam mechanism, the blanket table and printed sheet are forced from their normal position, the paper coming into contact with the guard *k* until it falls upon the face *l* of the cylinder C, when the grippers of *l* C seize it, and it commences to revolve in the opposite direction, the grippers of cylinder B releasing the other side of the sheet as soon as it is safely deposited reversed upon the impression surface of the lower cylinder; it is then carried forward to receive the second impression, on its unprinted side, from the forme 2. We have followed only one sheet from the cutting apparatus, round the cylinder until the operation of printing on both sides is completed; but it is unnecessary to point out that as there are sixteen formes spaced around the type cylinder, the process we have described is repeated eight times with each revolution.

The sheet we have been watching, after receiving its second impression, travels round with the cylinder C still held by the grippers until it is brought up opposite the collecting cylinder E, upon which it is rolled in such a position that its centre longitudinally is brought immediately under a pasting cylinder *m*, and a streak of paste is deposited along the middle of the sheet. The speed of the collecting drum E and the gripper action are so regulated that eight sheets are collected one above the other, and pasted down the centre, the pressure exerted by the paste duct as it comes in contact with each sheet, consolidating the contact between them underneath.

The strip of paste is, of course, also added to the outer sheets when they are taken off the collector and placed on the table *b* by the flyer *n*. The board *p* contains a pile of wrappers or covers; a boy places one at a time on the table *o*, the flyer puts down upon this wrapper the eight sheets of printed and pasted matter, and the rake-like frame *q* hinged at *r* presses the whole through the slot 5 between the two rollers below, which press the nine sheets together into book shape. The result is a long pasted pamphlet in length equal to the width of the continuous paper fed on to the machine at the other end, and in the case of the special work under notice consisting of a row of four thirty-two page pamphlets and a coloured wrapper, ready to be cut up under a cutting machine into ordinary single pamphlets. One man attends to the printing machine and a boy to the laying on of wrappers, and these two represent the staff necessary to attend to a machine, which is capable of turning out 2400 complete pamphlets of thirty-two pages per hour, ready printed, pasted, and placed in wrappers, when running at the comparatively slow speed of 600 revolutions per hour, equivalent to four pamphlets for every revolution of the type cylinder. The work

being turned out on this ingenious and very interesting machine is not, from a typographical point of view high class, but good work depends on a number of conditions besides a good machine, and we may safely say that none of the other conditions were fulfilled. Good type or good electros are of course absolutely necessary, and those in use on the machine are decidedly poor, and would, by many a printer, be pronounced bad. The paper is of the kind used for the cheapest newspaper work and the ink is of low quality, but we can quite understand that with first-rate electros, paper, and ink, good work may be produced on machines of the Feister type.

The inking apparatus used does not possess any novel features, but owing to the distribution of the plates on the circumference of the large type cylinder, two or more colour inkers could be used, made to act upon certain plates only, and by this means colour work could be produced on a machine of this type.

ON THE PROJECTED LISBON HARBOUR WORKS.

AFTER many years of discussion the plans for the improvements of the Lisbon Harbour have been finally agreed upon by the Portuguese Government; a sketch in these columns of this vast undertaking will therefore be both interesting and opportune, particularly as the proposed works will present features of considerable engineering difficulty and general interest. The high position which Lisbon takes among the South European harbours on the Atlantic is well shown by the steadiness of its increase in commercial importance. During the fifteen years ending 1883 the total tonnage of vessels entered and cleared has increased more than three and a half times. The tonnage of 1883 was 3,615,167,* about five-sixths of this shipping traffic being by steam vessels, and the remaining part by sailing vessels. Steam vessels alone have during the same period of fifteen years increased their total amount of tonnage about sixfold, the tonnage of sailing vessels remaining approximately stationary. A large amount of the steamship traffic, about one-half, pertains to the mail and passenger service, while the remainder consists of cargo and general traffic vessels.

The harbour of Lisbon is formed by the vast and magnificent estuary of the Tagus. Before reaching Lisbon the river widens itself into an extensive inland basin, the Mar da Palha, which in front of the town is narrowed again to a long channel, thus forming the entrance of the river into the sea (Plan, page 198). In this narrower part of the Tagus, between the town and the sea, the greatest depth of water is to be found. It is undoubtedly due to the strong tidal currents in this lower part of the river, occasioned by the great amount of tidal waters stored on the inland basin, that the inlet of the Tagus has been so remarkably well maintained. The river entrance presents a total width of 5000 ft. with over 33 ft. depth of water at low tide.

The greatest depths of water, measured at low water, are as follows: At the river mouth. 85 ft.; in front of the Tower of Belem, 130 ft. to 145 ft.; in front of the Cacilhas, 100 ft. to 130 ft. As shown in Fig. 1 the town lies on the north shore, partly in front of the Mar da Palha basin, partly along the lower channel. It is along the town where the works shown in Fig. 2 have been projected.

The favourable situation, facilities of access, and the vast dimensions of the well-sheltered and magnificent harbour are the advantages which have secured its already large shipping trade, and which promise to promote its brilliant future development.

The railway communications being now considerably increased, have not only centralised in Lisbon by far the greatest amount of business of this country, but tend to attract to the Portuguese metropolis a large share of the Spanish traffic to the Atlantic, as well as to develop the already considerable Transatlantic passenger and mail services. The Lisbon Harbour possesses, however, merely those advantages which, by its exceptional situation and conditions, have been given to it by nature; it has none of that dock accommodation with which almost any other European harbour of similar importance is so well provided. With exception of a few piers projecting into the river, there are no sites where even small vessels can be brought alongside; the present quays along the town being only to be reached at high water by small craft of the river service. Vessels are therefore obliged to lay on buoys and moorings in the river, and to receive or land their passengers and goods by boats and barges.

It is unnecessary to enlarge on the inconveniences, loss of time, and great expense which are daily occasioned through this existing primitive arrangement. The establishment of quays, docks, landing stages, and other needed improvements, has always presented considerable difficulties, which only now, after many years discussion, seem to have been overcome, and it still remains to be seen how far the economical resources of the country will be forthcoming for the realisation of the proposed extensive undertaking within the intended period of ten years. While, however, the inconveniences arising from want of proper accommodation are difficult to remove, there are others of no small importance which a better organised service could have lessened long ago, such as the delays caused daily through the old-fashioned regulations for sanitary, customs, and harbour inspection, which are of special consequence to the large amount of mail vessels calling at this harbour.

A great number of suggestions and plans have been submitted to the Government on the question of Lisbon Harbour improvements. Among these projects two by the eminent English engineers, Sir John Coode and Mr. James Abernethy, are to be found. In 1883 a Government Commission, including among its members many distinguished Portuguese engineers, among whom M. Mendes-Guerreiro is the best known, elaborated a general plan providing on a liberal scale for all the requirements of the harbour. In February, 1886, there were again laid before the Government a number of plans prepared by eminent foreign and Portuguese engineers, MM. Hersent, Reeves, Guérard being among the former and MM. Mattos, Loureiro, and Almeida d'Eça among the latter. It was only after so many competent opinions had been heard and valuable information acquired, that the Government charged the above-named engineers, MM. Mattos and Loureiro, to prepare an ultimate scheme, which has now been finally adopted; under the date of December 22nd last tenders for its execution were advertised for. The plans of February, 1886, as well as the now adopted scheme, are based on the original project of M. Mendes-Guerreiro, in which the most important feature was the construction of a river wall in front of the town. This wall is to be built as far into the river, that is, so distant from the present shore, as to secure sufficient depth of water for large vessels to float alongside it at any state of tide. The foreshore, which will thus be inclosed, will be available for the establishment of docks and open basins. Besides furnishing the harbour with a magnificent quay, similar to the recently finished Antwerp quay on the Scheldt, the river wall will be of considerable advantage for the sanitary arrangements of the town, and it is expected of favourable influence on the regulation of the tidal currents on this part of the river. If the last-named point should not be realised to any great extent, still the necessity of a river wall has lately become more and more imperative from its favourable sanitary influence it would exert. A great amount of deposits from the town drains take place along the flat shores in front of Lisbon as they formerly did in the Thames at London. At low water, particularly in the summer time, there prevail all along this lower part of the town exhalations and ill-smells which have proved to be the cause of sickness and fevers. With the construction of the river wall, all flat lands which at present become dry at low tides, will be embanked, the drains will be carried further into the river, and the outlets laid will be closer to the tidal currents.

Between the river quay and the present shore, arrangements have been made for the establishment of six open basins and one closed dock, altogether presenting a total water area of 120½ acres. The nature of soil upon which the proposed works will have to be founded, has proved somewhat unsatisfactory. Between the entrance of the closed dock and the Arsenal basin the solid strata lie at a considerable depth, there being above them a thick alluvial bed which reaches at about the centre of the Santos basin to its maximum height of 80 ft. The solid rock being here at 103 ft. under low water, the wall on this site would reach the considerable height of say 120 ft., should it become necessary to carry its foundation down to the solid ground. The existing information on the nature of the alluvial soil lying above the rock, is not sufficient to form the basis of a just idea as to whether this stratum will possess resistance enough to support the weight of the walls. The ground has been found to consist chiefly of mud more or less mixed with clay. It was also ascertained during the execution of the borings that the resistance of this soft stratum increases with its depth so much that at about 45 ft. to 50 ft. under low water, borepipes were no longer required for working the holes down to the rock.

Based on this observation the Government engineers suggest that the foundations of this part of the works shall be carried down to these depths, as they suppose that sufficient resistance will be met with to support the weight of the proposed construction. It remains, however, to be seen how far this will be practicable in a soil which is likely to be subject to settlements, so much to be feared in works of this magnitude. In order to avoid an additional weight of an embankment, the outside of the Santos basin will be limited by a solid jetty of 19 ft. 8 in. width on the top. It has been suggested that this shall be built of blocks, founded at 19 ft. 8 in. under low water on a rubble mand dam. The blocks of the jetty will be laid on an incline in a similar way to that often employed in superstructures of Indian breakwaters. The top of the jetty being placed at 19 ft. 8 in. above low-water, its total height will be about 40 ft. The rubble stone dam will be placed on a channel dredged down to 46 ft. under low water, its total height being therefore about 26 ft. A similar wall of 32 ft. 9½ in. width on the top, has been suggested for the outside of the two basins of the Custom House and of the Terreiro do Trigo.

This system of construction, as well as any other proposed for the remaining part of the works, is not positively determined, it being left free to the contractor of the works to employ any other convenient kind of foundation, provided that it meets with the approval of the authorities. The most generally accepted system of execution of the walls, under the existing unfavourable circumstances, has been that of compressed air, with which excellent results were recently obtained in works of this kind in Antwerp. It is, however, to be noticed that the depths to which the foundations were carried in those works were inferior to those which might become a necessity on the Tagus, and that therefore greater difficulty might be met with than in Antwerp.

M. Hersent, the engineer, of MM. Couvreux and Hersent, the well-known contractors for the Antwerp works, proposed this system of compressed air, carrying the foundations in some instances to over 100 ft. under low water. On account of the considerable height of wall attained, it was impracticable in these cases to keep the usual proportion of 1:2 to 1:3 between the width of wall at the foundation and the total height. He, therefore, suggested that the wall should be strengthened by rubble stone thrown on the back and in front. Thus for a wall of about 120 ft. height the lower part of the rubble stone has been placed at 49 ft. under low water, rising in front of the wall up to 28 ft. under low water, and on the back up to the top 18 ft. above the same water mark.

The thick stratum of mud found specially on the site of the Santos basin and of the Arsenal basin, decreases so far towards the west end of the works that the foundations of the closed dock and its entrance lock show scarcely any of this alluvial soil, which is being replaced by strata of sandy gravel and clay lying in varying thicknesses above the rock. The foundations of this dock will be based to a great extent on the rock itself.

The river wall will run from the pier of the railway station on the east end of the town down to the Cordoaria in Belem (Fig. 2). The total length of this distance, measured in front of the quays, will be 20,454 ft., including the entrances of basins, the total extension of the river wall itself being 19,011 ft. The depth of water in front of these quays has been determined, for the greatest extent, at 27 ft. 11 in. at low water, the coping of the wall and of the inside basin being placed at 19 ft. 8 in. above the same mark.

Taking low-water mark at 0, we show in the following figures the relative position of the different states of tide:

	ft.	in.
Low-water mark (lowest low water) ...	0	0
Ordinary low water...	3	9
High-water neap tides	10	4
Ordinary high water	12	3
High-water spring tides	13	10
Highest high water...	15	11

The question as to whether preference should be given to the establishment of open basins or of closed docks has drawn forth a considerable variation of opinion. While some engineers preferred the greatest part of these basins to be constructed as closed docks, so as to maintain a constant water level, with which greater facility is obtained in loading and discharging vessels, others proposed exclusively open basins for their greater facility of access at any state of tide. It seems, indeed, that in a harbour which has been developed perfectly under the influence of free communications, the changes brought about by the exclusive preference of closed docks would likely bring inconveniences into the local habits of commerce. This was, for instance, one of the chief reasons for the adoption of open basins in the Hamburg Harbour, where a considerable amount of goods traffic takes place by means of barges. The inconveniences arising in closed docks from the crowding of numerous river craft, which delay the passage of vessels through the entrance lock, are nowhere so well exemplified as in most of the docks of London. In Lisbon, where the range of tide is not great, and therefore the difference of expense between both systems of no considerable weight, the greater preference given to open basins seems more justified, as a great amount of communication in the harbour is made by small craft. Open basins are, however, likely to facilitate the deposits occasioned by the in and outflow of the tide, and therefore to require greater dredging expenses for the maintenance of the depths. The disposition of the basins has been arranged so as to separate, as much as possible, from each other the different kinds of services for which they have been adopted.

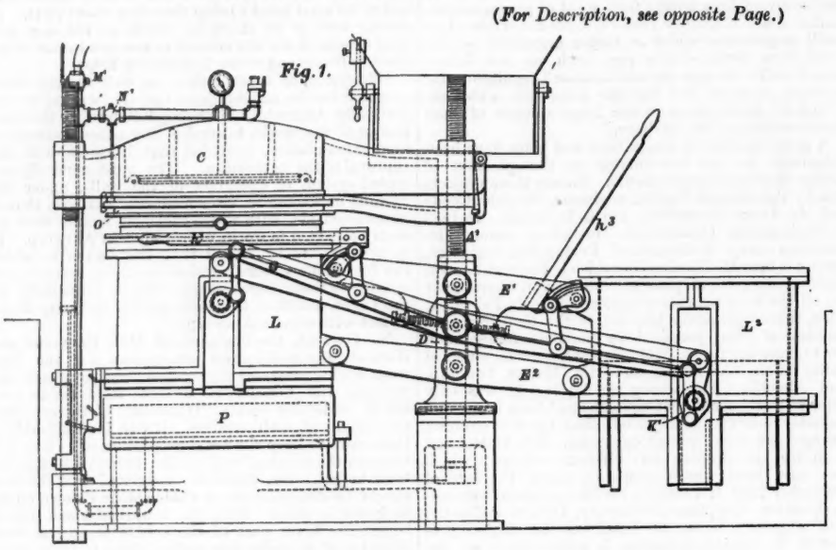
The closed dock will have a total area of 35.3 acres,

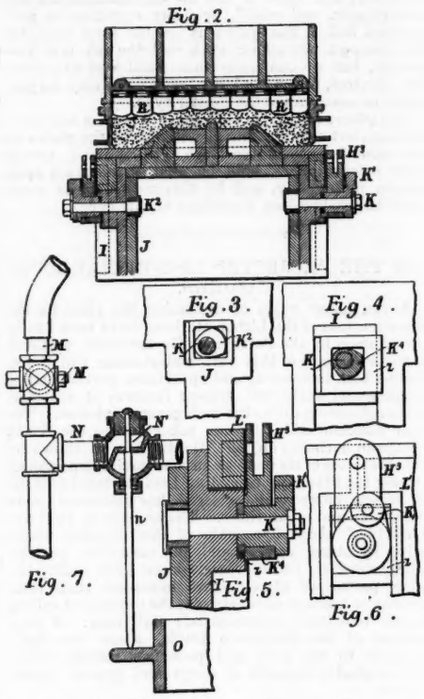
* In the above figures, which are the last official returns known to the writer, the tonnage of coastwise craft is not included.

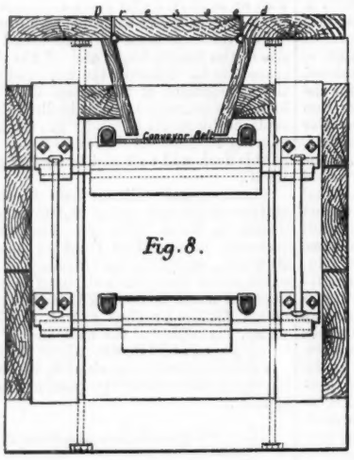
PNEUMATIC MOULDING MACHINERY.

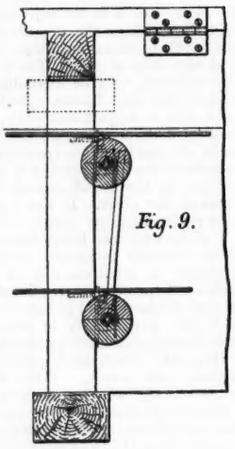
CONSTRUCTED BY THE PNEUMATIC COMPANY, INDIANAPOLIS, IND., U.S.A.

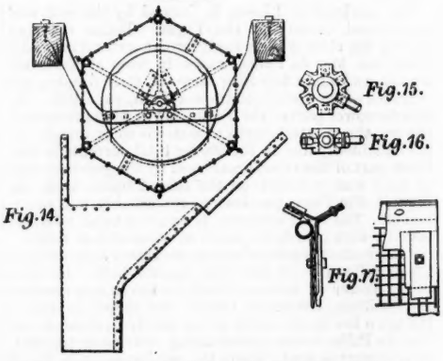
(*For Description, see opposite Page.*)

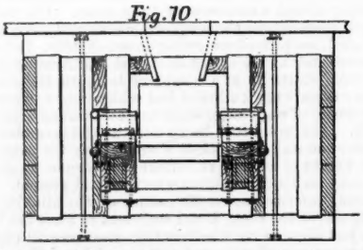


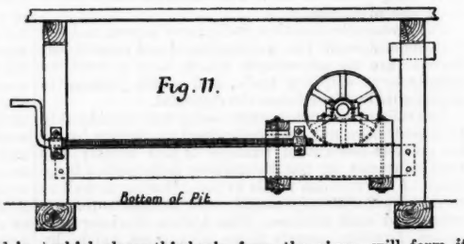












or say 0.292 of the whole water surface of the seven proposed basins. It is to be entered from the basin by a lock 574 ft. long with a width of 82 ft. On the north side of this dock a pitched slope, 984 ft. long, will be established, the remaining water line to be provided with quays presenting 30 ft. water depth at high water. On the east end of the basin two dry docks have been projected, the largest of which is to be 525 ft. in length and 82 ft. in width of entrance. Close to the same the second dry dock, of 328 ft. length and 49 ft. 2 in. width of entrance, will be erected. This end of the dock has been exclusively adapted for naval repairs; arrangements have, therefore, been here made for the construction of a slipway and a place left for a third smaller dry dock.

Dry dock accommodation is, indeed, the most urgently needed improvement of the Lisbon Harbour; it is, therefore, much to be regretted that under the present circumstances, the difficulties of execution, and vast dimensions of the proposed undertaking, the existing want is not likely to be removed within an early period. Vessels requiring repairs or inspection, finding no establishment for this purpose in Lisbon, are obliged to undertake a voyage either to English or French ports, or to Cadiz, on the south coast of Spain. The south side of the closed dock is to be provided with a quay running parallel with the river wall at 328 ft. distance from it. This space, between the front of both walls, will be provided with four sheds of 65½ ft. width and 2392 square yards area each, which will be placed along the inside quay. The remaining space to be provided with six railway lines, one of which will cross the lock by a swing bridge into the north side of the entrance basin.

The entrance basin will communicate with the river by an opening 492 ft. wide. The minimum depth of water in this basin will be 27 ft. 11 in., this being sufficient for large mail vessels to enter at low tides. At its east end the entrance basin will be connected with the next Santos basin by an opening 98 ft. 4½ in. wide, left in an embankment of 246 ft. width.

The Santos basin, which has also an opening 492 ft. in width, will have a total water area of 39.3 acres and will be used for general traffic purposes, not receiving, however, the largest vessels for which the closed dock and the entrance basin have been adapted. Its depth of water at low water has been determined at 19 ft. 8 in.

Along the north quay of the entrance and Santos basin, three sheds of 65½ ft. width and a total area of 7176 square yards, will be established and provided with the necessary railway communications. The embankment marked A on the plan, is intended for the erection of a general post office, and that marked B for a large and central railway station. These buildings are not included in the present projects adopted for execution.

Further eastwards we find the Arsenal basin, which has been placed in front of the Royal Arsenal in order to utilise the existing accommodations for the Royal Navy. An opening of 98 ft. 4½ in. width left in the wall which closes this basin from the river, will form its entrance. The depth of water in the Arsenal basin has been fixed at 27 ft. 11 in. at low water. Still further eastwards we find the Custom House basin and the Terreiro do Trigo basin, both of which are intended for the accommodation of barges and small craft of local service. Each of these basins will have a water area of 3.7 acres, and will be reached by 98 ft. 4½ in. entrances, the first basin being dredged down to 16 ft. 5 in., the second down to 13 ft. 1½ in. under low water. The St. Amaro basin, at the west end of the works, is intended for the requirements of small craft belonging to this part of the town. It has been left free to the contractor to include or not in his tenders the construction of this basin, as well as the river quay from the Caneiro d' Alcantara down to the Cordoaria; absolute preference being, however, given to any tender which contains their execution within the total estimate of 2,400,000*l.*, the amount fixed by the Government for the contract of the whole undertaking.

From the table of dimensions of the works on the next page, the following results have been obtained:

ELEVATORS AND HOPPERS FOR MOULDING SAND.

CONSTRUCTED BY THE PNEUMATIC COMPANY, INDIANAPOLIS, IND., U.S.A.

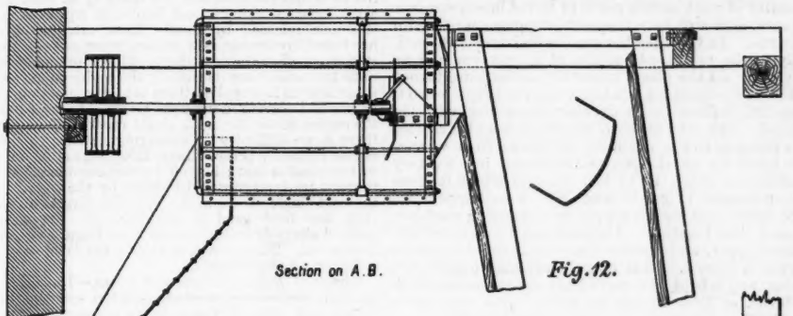


Fig. 12.

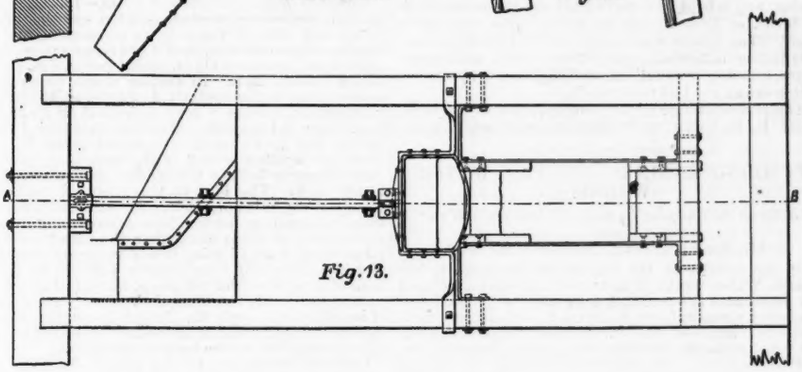


Fig. 13.

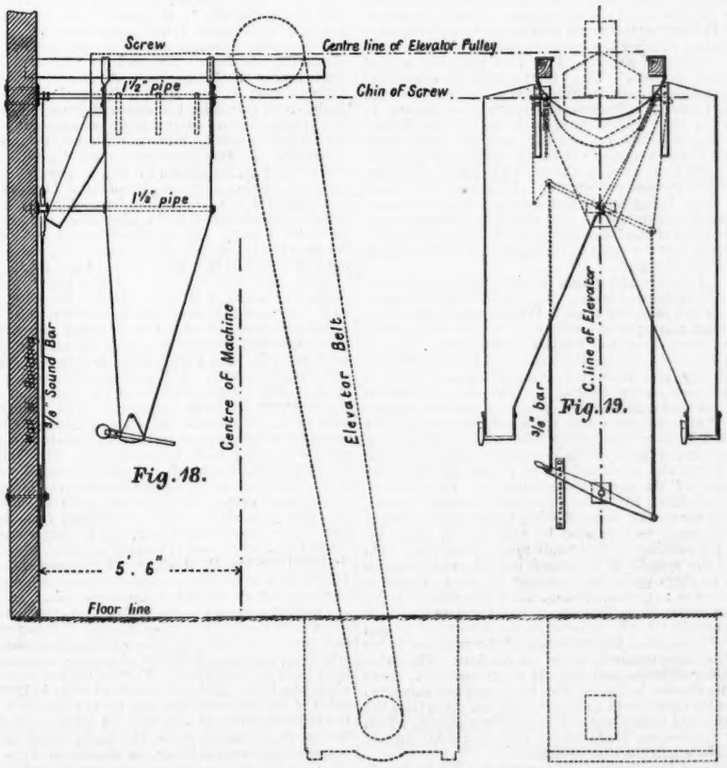


Fig. 18.

Fig. 19.

	ft.
Total length of quays (river wall and all basins)	37,016
Total length of quays of all basins ...	18,000
,, ,, pitched slopes of all basins	2,788
,, water area of all basins	120⅝ acres.

A lineal length of say 150 ft. of quay has thus been obtained per acre of water of the proposed seven basins.

The sheds to be erected on the three larger basins will be eight in number, presenting a total covered surface of 19,136 square yards.

The works above described form the first and most important part of the proposed scheme in the Lisbon Harbour. Next to these the following further improvements have been suggested by the Government engineers:

1. A river wall from the west end of the present project to the tower of Belem. Plan No. 2.

2. A river wall from the railway station upwards to the Beato.

3. An embankment partly protected by a rubble stone dam for the regulation of the south shore of the Tagus from Cacilhas to the Trafaria.

The official Government paper *Diariodo Governo*, of December 22 last, published the conditions for the contract of the works at present decided for execution. In the following we give an abstract of the same.

The works above mentioned of the river quay docks, basins, dredgings, provided with all necessary hydraulic and other machinery, gates, bridges, caissons, cranes, and railways to be carried at the contractors' own risk and responsibility, and with his own materials, machinery, and plant within the period of ten years, for a total amount not to exceed 2,400,000*l.* Absolute preference will be given to any tender, including in the above estimate the construction of the river quay wall from the Caneiro d' Alcantara to the Cordoaria, as well as the St. Amaro basin.

Table of General Dimensions of the Proposed Lisbon Harbour Works.

—	Water Area of Basins.	Length of Quays.	Length of Pitched Slopes.	Width of Entrances.	Depth of Water at Low-Water Mark.
	acres	ft.	ft.	ft. in.	ft. in.
Santos basin	39.3	2,588	984	492 0	19 8
Closed dock	35.3	3,854	984	(Lock) 82 0	19 8
Entrance basin ..	23.2	3,641	..	492 0	27 11
Arsenal basin ..	7.7	1,394	328	98 4½	27 11
Custom House basin	3.7	2,034	164	98 4½	16 5
Terreiro do Trigo basin ..	3.7	1,870	328	98 4½	13 1½
St. Amaro basin ..	7.9	2,624	..	98 4½	6 7
River quay wall ..	..	19,011*	..	..	27 11†
Total	120.8	37,016	2782		

* Including the wall from Caneiro d' Alcantara to Cordoaria, 3116 ft. length.

† A part of the river wall will have only 19 ft. 8 in. depth at low-water.

Any delay caused by any reason whatever, excepting war, in completing these works within the said period of ten years, will entitle the Government to receive damages from the contractor not exceeding 444*l.* for every month of delay. Tenders to be delivered in Lisbon on March 26, 1887, each tender being accompanied by a deposit of 120,000*l.*, to be made to the Government up to the same date. Tenders to be also accompanied by reports and plans generally specifying the projected system for execution of all foundations, and to supply all information necessary for the just appreciation of the submitted plans. The Government is to decide the contract within fourteen days from the date of delivery of tenders, the contractor being bound to begin the works within thirty days after his tender being accepted. Within ninety days from the date of approval of the tender the contractor will be bound to deliver to the Government all general plans, detail drawings, justifications of systems of construction, disposition and description of all machinery, buildings, bridges, gates, &c., complete and ready for execution of the works. The contractor will be bound to maintain during one year's service ironwork of every kind, delivered by himself, and to maintain at his own expense all other works during three years after the date of the same being officially accepted as concluded.

THE PNEUMATIC METHOD OF MOULDING.

IN a previous issue* we gave an account of the pneumatic method of making moulds for casting, practised by the Pneumatic Company, of Indianapolis, U.S.A. Since that time very considerable alteration has been made in the machines by which this process is carried out, and now they have attained a much greater speed of working than at the time of our former notice, and both boxes, when there are two to the casting, are prepared in succession, and can be immediately put together, instead of a number of top boxes being prepared first, and being followed by an equal number of bottom boxes, as heretofore. A comparison of the engravings on our two-page plate with those on page 396 of vol. xxxix., will show at a glance that the alteration has required the entire reconstruction of the machine.

The pneumatic method of moulding is extremely simple, and is so automatic that it can be carried out by unskilled labour, for all the features of the moulder's art requiring judgment, are elimitated. There is neither ramming nor venting required; the mould lies at the bottom of the box, and the space above it is filled with sand, which is then pressed down to a uniform density by a number of air-bags or cushions placed above the sand and between it and a fixed platen. These bags, under the influence of compressed air, adapt themselves approximately to the form of the pattern, consolidating the sand at all parts with an equal pressure, the thin layers being no denser than the thicker ones, and the whole being so lightly consolidated that the gases can escape at all parts without the use of venting holes. Yet, although the sand is so lightly rammed, boxes of comparatively large size can be used without the usual bars across them. The pattern is withdrawn downwards through a stripping plate or silhouette, and if it should comprise any very projecting parts, these are drawn first, the other portions of the pattern forming a stripping plate

* See vol. xxxix., page 394.

for them, and preventing the edges of the mould from being dragged.

Every one must be struck with the beauty and simplicity of the process, which avoids the difficulties hitherto experienced in machine moulding with rigid platens and turns out castings which are exact representations of the patterns, and are not affected with honeycombs.

The arrangement of the air bags, the sand, and the pattern is shown in section in Fig. 1 (page 202). The bags R are made in compartments to give strength, and also to add to their facility of movement, in order that they may follow the sand into the deep hollows in or around the pattern. The pattern itself is fixed on a plate by which it can be automatically withdrawn through the stripping plate, to allow the finished box to be removed. One-half of a pattern is shown in the lower view on the two-page plate, while the other half is covered with a box which has just been moulded, at the left-hand side of the machine. To carry on the operation the pattern at the right-hand side must now have a moulding box placed on it, and over this the thin counterweighted sand-box, shown on the left-hand box. The object of the sand-box is to increase the capacity of the moulding-box, so that it may hold enough sand to allow for the compression which it experiences. The sand-box is carried by counterweighted levers pivotted to the central column of the machine, and capable of being adjusted to any required height of box. When the boxes are in position they are brought, by swinging the whole arrangement round the central column, under a sand hopper (Fig. 17), not shown in the perspective views. There the boxes are filled with sand, and are then ready to be compressed, by being moved into the position shown at the right of the lower perspective view. The pattern chest then rests on a short inverted air cylinder, which can rise and fall on a solid piston or platen on the foundation plate. This cylinder has a much greater area than the air bags in the platen above, and when compressed air is admitted to it, it holds the box firmly against the top platen. Air is then admitted to the bags until the gauge shows the determined pressure, or until a weighted valve blows off. The half mould is then complete, and all that remains is to withdraw the pattern. This is effected by the hand lever shown in both views, which operates two bell-cranks connected to sliding blocks. These blocks are coupled to the patterns, and rise and fall with them. When the pattern has been lowered the air pressure is released from the cylinder, the box descends, and can be swung into a convenient position for removal. Next the other half pattern is treated in a similar way, and the mould is complete, the whole operation occupying only a very brief space of time.

The above is a short and very general account of the machine shown in the perspective illustrations. We will now turn to the detail views (pages 202-3), which represent a modified machine designed for patterns which need to be withdrawn at two operations, the high portions being caused to recede first, and being followed by the general body of the pattern. This arrangement requires a duplication of the levers, but in other respects does not alter the main features of the machine. The two pattern chests L^1 L^2 are mounted on arms or beams E^1 E^2 pivotted to a sleeve D capable of revolving on the centre port A^1; the two chests counterbalance each other, and, as they are raised or lowered, always keep their horizontal attitudes. The tilting of the lever E^1 E^2 is limited by adjustable stops made in the form of screws tapped through arms extending down from the upper lever E (see perspective views). The levers are broad skeleton frames, and are connected at points widely separated so that they also hold the pattern chests firmly against all twisting strains. The pattern chests (Fig. 2) are provided with two or more pattern slides I, J, one within the other, and the various parts into which the pattern is divided are attached to these slides. The slides are operated by the hand levers h^1 h^2, which are pivotted at the point of attachment of the lever E^1 to the pattern chests, and are connected by links to the lever K^1 on short shafts K extending through the trunnions of the outer slides I, and carrying cams K^2 K^4 (Fig. 5) working in horizontal slots in the several slides, so that a partial revolution of the shaft K will give a vertical movement to each inner slide, but not to all at once. A cam K^4 (Fig. 5) on each shaft K operates in a horizontal sliding box z, which is carried in the outer slide I, and serves as a bolt to hold or release it, by engaging in or disengaging from a corresponding cavity in the adjacent portion of the pattern chest L^1. It locks the slide I against sinking until the inner slide J has been withdrawn from the sand by the action of the cams K^2 (Fig. 3), after which the further rotation of the shaft K draws the bolt z, and leaves the whole system of slides at liberty to sink. Finally the lever G brings the pattern slides I J down together as far as may be required.

After a moulding box has been placed between the cylinder P and platen C, the valve M^1 (Fig. 7) is opened, and air under pressure is admitted to the cylinder P to raise the box against the platen. As the box rises a projection O meets the stem of the valve N^1, and admits air through it to the flexible pressers R (Fig. 2). The sand is then pressed down to the pattern, and the mould completed.

A machine capable of dealing with such a large quantity of work as this needs to be fed in a systematic manner, or it will have frequent stoppages waiting for material. In this case the sand is delivered automatically to the machine by means of a conveyor and an elevator. At the places where the castings are turned out of the boxes there is a belt conveyor (Figs. 8 to 11, page 202) built with its decking about level with the ground. The sand is shovelled into this and is carried to a pit close to the moulding machine; from whence it is lifted by an elevator and delivered into a rotary sand screen (Figs. 12 to 17), through which it drops into a hopper (Figs. 18 and 19). Two hoppers are here shown designed to supply two moulding machines erected close together. The sand can be directed into either hopper, and remains there until the door at the bottom is opened. This door is pivotted outside the casing, and is bent to a curve from the centre on which it turns, so that it can be moved with very little effort. The details of the conveyor are clearly shown; it is framed in timber, and contains a belt, with roped edges, running over rollers, and tightened by screws which draws the last roller back.

The representative of the company, now in England, is Mr. R. M. Coffin, of 12, Half Moon-street, London.

PUMPING ENGINES; LINCOLN WATER WORKS.

*Notes on the Pumping Engines at the Lincoln Water Works.**

By Mr. HENRY TEAGUE, Engineer of the Works.

ON the occasion of the visit of the members to the Lincoln Water Works at last year's summer meeting of the Institution (Proceedings, 1885, page 446), a good deal of interest was manifested in regard to various mechanical details in connection with the pumping engines, respecting which numerous inquiries were made both at the time and subsequently. Having been requested to furnish some particulars respecting these details and the reasons for their adoption and the experience of their practical working, the author has much pleasure in complying with the request by offering the following notes.

Sims' Compound Engine.—The first pumping engine was erected in 1848. This is the original compound engine first constructed on Sims' plan, having the high and low-pressure cylinders continuous, as shown in Fig. 1, page 199. It had been made in 1836 by Messrs. Harvey, Hayle Foundry, Cornwall, and had been working on two Cornish mines before its removal to Lincoln. A 25 in. cylinder is fixed on the top of a 50 in. cylinder, and the two pistons are on one piston-rod, the space between them being at all times open to the condenser. The length of stroke is 8 ft., and the 12 in. plunger pump at the other end of the beam has a stroke of 7 ft. The valve arrangements are the same as those of an ordinary single-cylinder Cornish engine.

Balance Valves.—The pump works against a pressure equal to 350 ft. head of water, the city drawing its supply direct from the pumping main. When a main pipe burst or a hydrant was opened quickly, it was found that the catch pins came down too heavily on the spring beams. To avoid this, the author in the autumn of 1848 fixed in the main delivery pipe from the pump a balance valve of the construction shown in Fig. 2. The valve D is a flat disc on a vertical spindle, closing upon a seating below; and is held open by two spiral springs S, pressing against a crosshead H upon the spindle above the stuffing-box. The upper end of the spindle is screwed, and fitted with a nut N above the crosshead H, by means of which the compression of the springs is adjusted to the required amount for holding the valve open to the extent desired, against the current of water flowing downwards through it from the pump, as indicated by the arrows. Any increase in the velocity of flow tends to close the valve. On the top of the spindle is a second nut M, which can be adjusted to drop upon the crossbar B, so as either to limit the valve to partial closing, when it is desired to let the engine continue working on, or else to allow the valve to close entirely; in the latter case the lower nut N can be screwed up against the underside of the crossbar B for holding the valve down securely on its seat. The valve spindle being of brass, and only 1½ in. in diameter, there is but little friction in the stuffing-box; and the valve has consequently been found to be far more sensitive than the double-beat and treble-beat valves usually adopted, which by their friction on their centre pole or guide pin are caused to be much too slow in action.

Exhaust and Equilibrium Valve Catches.—To be as safe as possible, and hold the engine at either end of the stroke whenever the catch-pins strike the spring beams, catches were at the same time applied to the shafts of the exhaust and equilibrium valves, as shown in Fig. 3. This view illustrates the case in which either the steam valve or the top delivery clack of the pump has failed to close as promptly as it ought to do, and the pressure of steam has consequently been in excess of the load in the indoor or downstroke of the pistons; the upper tappet T on the plug rod P has consequently depressed the handle of the exhaust shaft E so far that the bottom catch C has caught; and it will so remain, holding the exhaust valve shut, until released by the engine-man. The steam catch is liberated by a rod and lever fixed on the exhaust shaft; consequently its liberation is prevented, and the steam valve also is held shut, until the bottom catch C is released. The top catch on the equilibrium shaft Q acts in a similar manner whenever there is a decrease of load in the upstroke of the pistons; the lower tappet on the plug rod then lifts the handle of the shaft Q so high that the catch becomes caught, and holds the equilibrium valve shut until released by hand. These catches the author has found invaluable, the engine being caught and held stationary after the next single outdoor or indoor stroke, until the catches are released by the engine-man; and ever since 1848 he has applied them to all the pumping engines he has had erected in different towns. Instead of letting the engine make the next single stroke before stopping, there is no difficulty in arranging catches to hold the engine instantly (Proceedings, 1853, page 112), and it was so intended at first; but on further consideration it was thought no damage would be done by the engine making the next single stroke in the opposite direction, and this view has held good in practice, the present simple method above described having been found to be all that is required. The opening of the valves is effected in the ordinary way by weights.

Combined Bucket and Plunger Pump.—In 1852 a small auxiliary engine was erected, and the question arose as to the best kind of pump to be adopted. After some consideration a combined bucket and plunger pump was decided upon, having an 11½ in. bucket and an 8 in. plunger, with a stroke of 2½ ft. In working it was found that, in consequence of the contracted waterway through the bucket clack, it made a great noise both in opening and in closing; and the author therefore determined that, if he ever had to fix another combined pump, he would substitute a piston instead of the bucket, and provide a clear waterway both in the suction clack and in the delivery clack. The idea of the combined bucket and plunger pump he believes to have originated with Smeaton, though claimed by many others subsequently; indeed, even as late as three years after the author's own application of it at Lincoln, it was twice announced as a new idea. Naturally to an observer watching the delivery head of an ordinary bucket-pump, when the large wooden pump-rods were in use, it required no very great stretch of imagination to apply the plunger in combination with the bucket, seeing that in the descent of the rod a volume of water equal to its own bulk was displaced.

Combined Piston and Plunger Pump.—In 1862, being in want of more pumping power, it occurred to the author that, as the city draws its supply direct from the main and only the surplus is delivered into the reservoir, a double-acting flywheel engine would not be so much affected by a sudden withdrawal of water as the ordinary single-acting beam engine. A 36 in. single cylinder double-acting engine with 8 ft. stroke, and with six double-beat valves for the steam distribution—two steam, two expansion, and two exhaust—was accordingly erected, having been made by Messrs. Williams, Perran Foundry, Cornwall. To this engine was applied a combined piston and plunger pump, shown in Fig. 4, possibly the first of the kind, having a 12¾ in. piston and a 9 in. plunger, with a stroke of 7 ft.; the valves were Harvey and West's double-beat clacks of 14 in. diameter (Proceedings 1858, Plate 61, Fig. 1). The flywheel was placed intermediate between the pump and the beam centre, the cranks having a stroke of 4¾ ft. The action of this engine was satisfactory, with the exception of the heavy beating of a single-flap clack in a 15 in. bucket lift with a head of 20 ft. for raising the water on to the filter beds.

Relief or Break Clack.—For obviating the annoyance of this concussion, without incurring the expense of a double-beat clack for such a situation, the author began to devise some simple remedy. A 4 in. break valve he was aware had been applied by Mr. Gribble at the beginning of the present century to a 16 in. exhaust valve in a pumping engine with 91 in. cylinder at the United Mines, Cornwall; it was quite a success, and is sketched from memory in Figs. 5 and 6, showing both valves closed. The long slots in the lugs on the large valve allowed the small valve to open first, which was found a great benefit in relieving the load on the large valve. On the other hand the author knew that the pyramid of clacks, sketched from memory in Fig. 7, had practically failed; and no better result had attended the treble clack (Proceedings, 1858, Plate 61, Fig. 3) designed by Mr. R. Jenkyn, of Copperhouse Foundry, Hayle, in which three separate rings were hung one upon another, but all hinged on the same side. In regard to the last, it occurred to the author that the reason of the failure lay in the three clacks being all hung on the same side; and that, had they been hung alternately on opposite sides, the desired aim of obviating concussion would have been accomplished. To test the correctness of this view, the 15-in. clack was removed early in 1863, and one-third of its area was cut out in the centre of the flap; the aperture so made was covered with a supplementary leather clack hinged upon the main clack at the edge opposite to the main hinge, as shown in Figs. 8 and 9. By this means the concussion was so completely prevented, that by placing the hand or ear in contact with the clack box not the least tremor or sound was perceptible, and the time of closing could not be detected. The leather of the small supplementary clack continued in constant action for seven years before requiring to be changed, and that of the main clack for thirteen years. In 1866, when the Harvey and West double-beat valves in the 14 in. main pump began to leak, the author replaced them with leather break clacks of this construction, whereby the action of the pump was greatly improved, as shown by the two pairs of diagrams in Figs. 10 and 11, which were both taken under similar circumstances when the pump was travelling at 160 ft. per minute. These diagrams were taken with a McNaught indicator having a spring of 10 lb. per inch of range. Fig. 10 shows the vacuum above the clacks, which at the commencement of the stroke is 5½ lb. per square inch for the break-clack, as

* Paper read before the Institution of Mechanical Engineers.

shown by the lower line, and 7 lb. for the double-beat valve, as shown by the upper line; Fig. 11 shows the vacuum below the clacks, which began at 4 lb. per square inch in each case. The suction pipe is 13 in. in diameter, and runs 40 ft. horizontally from the pump before dipping into the tank, in which the water level at the time of taking the diagrams was 6 ft. below the bottom clack. In taking a number of diagrams similar to those shown in Figs. 10 and 11, it was found that scarcely any two were exactly alike. This was attributed in most instances to the undulatory motion of the water in the tank from which it was being pumped; the tank was 70 ft. long by 40 ft. wide, and the undulation was sufficient at times to raise the indicated line above the atmospheric line at the finish, as shown by the dotted line in Fig. 10. In some pumps with a vacuum of about 7 lb. per square inch or 16 ft. head of water at the commencement of the upstroke, the indicated line has been raised several feet above the atmospheric line at the finish. To obviate this evil with a long horizontal suction-pipe, it occurred to the author in 1852 to interpose at the foot of the pump a large air-tight box or vacuum vessel, for the long horizontal suction pipe to deliver into; the vessel contains sufficient vacant space to spare for taking up the fluctuations of the water, which are thereby prevented from affecting the working of the pump. This addition has been found to answer the purpose thoroughly, the pumps working with the greatest ease when so supplemented. The author was led to the introduction of the vacuum vessel in consequence of being consulted about a 4-in. hand pump, to which had been laid a 2-in. suction pipe of 480 yards length, with a vertical dip of 8 ft. at the well end; although the pipe was filled at starting, the pump would not draw any water, until he added a vacuum vessel of six times the cubic content of the pump. This rendered the action so easy that a boy could work it. On the construction of the Gainsborough Water Works in 1866, the vacuum vessel was called into requisition for a 12 in. plunger pump, supplied from the river by a 10 in. suction pipe of 1000 ft. length; the pipe runs 425 ft. horizontally from the river, then rises 16 ft., and thence runs 575 ft. horizontally to the pump. In several other instances the vacuum vessel has been applied with equally good results.

The break-clacks (Figs. 8 and 9) work incessantly for five years without changing a leather, and without showing the least sign of leakage, under 350 ft. head of water or 150 lb. per square inch; and there is not the slightest concussion, the time of closing not being perceptible. For a velocity of 160 ft. per minute of the pump the author has found the weight of the flap should be about 2 lb. per square inch. On the top of the second or supplementary clack a third of still smaller diameter can be applied, and even a fourth or more hung alternately on opposite sides.

In 1884, when it was found that still further pumping power was required, the author decided to revert to the Cornish pumping engine, notwithstanding the consideration which had previously led him to choose a double-acting flywheel engine in 1862, namely, that the city draws its supply direct from the main. For the experience gained from the working of the Cornish pumping engines which he had erected in the interval at Grantham, Maidstone, and other places, had convinced him that the cost of coals and repairs had been reduced in some instances to as low as only one-sixth of the annual expenditure pertaining to rotary pumping engines previously in use there. The new Cornish pumping engine accordingly procured from Messrs. Harvey, Hayle Foundry, was started in March, 1885, and its action has been all that could be desired, while the saving of coal has been no less than 543 tons in ten months. The cylinder is 58 in. in diameter and 9½ ft. stroke; the plunger is 18 in. in diameter and 8 ft. stroke, with three of Harvey and West's double-beat clacks. The main girders and spring beams are of wrought iron, with india-rubber buffers to receive the catch-pins. Every joint in the cylinder, and in the steam, feed, and other pipes, and also in the pump work, is faced; and all are bolted together, iron to iron, with only thin paint between. The shafts of the exhaust and equilibrium valves are fitted with the useful catches previously mentioned. In the equilibrium pipe is placed a check throttle valve V, Fig. 3, which is adjusted by a hand-wheel W according to the proper load from time to time upon the engine (Proceedings, 1853, page 111, and Plate 25, Fig. 4). This keeps the speed of the engine under perfect control in the outdoor or upstroke of the pistons, against any ordinary fluctuations in the load. The valve is opened wider whenever the load is permanently increased, and is closed further if the load is reduced; the range of load is from 220 ft. to 350 ft. head of water. The delivery main from the pump is fitted with Husband's balance valve, Fig. 12, which is a double-beat valve loaded with an adjustable dead-weight; but owing to the friction of the stuffing-box round the plunger of 8 in. diameter attached to the valve, this is not found to be so sensitive as the balance valve previously adopted by the author, which is adjusted by springs, as already described.

Coal Consumption.—The Sims compound engine and the 36-in. double-acting flywheel engine are found to consume about 4 lb. of coal per horse-power per hour for actual work done. The 58 in. Cornish engine consumes 3.14 lb. per horse-power per hour in the ordinary course of working, without any special arrangements being made for a test. The coal used is the Nottinghamshire and Derbyshire slack; its evaporative duty the author believes does not much exceed 7 lb. of water per pound of slack, and varies between that amount and only two-thirds as much; its efficiency is therefore not to be compared with that of Welsh coal.

About 1½ miles west of the city, and a mile west of the filter beds and pumping station, is the impounding reservoir of 23 acres area, which forms an ornamental lake in the grounds of Hartsholme Hall. On the Cross o' Cliff hill, 1¼ mile south of the pumping station and near the county asylum, is an open service reservoir holding 1½ million gallons. On the opposite hill, two miles north of the pumping station, and near the cathedral, is another open service reservoir holding 800,000 gallons, into which the pumping main delivers over a standpipe. When the consumption below hill is greater than the quantity pumped by the main engines, no water will rise over the standpipe; this occurs not only in extremely hot weather, but also on very cold days, when taps are left running to waste in order to prevent freezing. A 6 horse-power gas engine is therefore provided for pumping back over the standpipe out of the reservoir, to supply the upper part of the houses situated on the top of the hill; and there is a back-pressure valve on the crown of the hill, for preventing the water so pumped back from flowing down the main below hill.

Sewage Pumping Engines.—At the sewage pumping station, situated in the valley about half a mile east of the city, the sewage is pumped up and delivered on to the corporation farm by a pair of vertical compound engines made by Messrs. Hathorn, Davey, and Co., Leeds. The high-pressure cylinders are 15 in. in diameter and the low-pressure 30 in. in diameter, the length of stroke being 5 ft. The plunger pumps are 22 in. in diameter with 5 ft. stroke. The feature that recommended these engines was the differential gear for catching the engine in case of the fouling of the clacks or bursting of a main.

MISCELLANEA.

THE annual general meeting of the London Chamber of Commerce was held on Monday last.

The Neptune has been fitted with a couple of iron masts, with military tops for machine guns.

The harbour of Trieste has been lighted by electricity. Forty-five powerful arc lights are used for the purpose.

The accidental discharge of the Ajax's gun into Mr. Patton's garden, at Innelan, was owing to the accidental completing of the gun circuit.

The Panama Canal Company has bought thirty locomotives in Belgium, eighteen of the St. Leonard Company, and twelve of the Cockerill Company.

It is stated that the Royal Commission on Warlike Stores will report shortly and the report will be presented to Parliament without delay.

Sir David Salomons has revised his little handbook on the "Management of Electric Accumulators," and will publish shortly, through Messrs. Whittaker and Co., the second edition.

The whole of the rolled case cartridges for the Martini-Henry rifle are manufactured in the Royal Laboratory at Woolwich, and their cost is 3*l.* 2*s.* per 1000 B.S. No. 1.

The Board of Trade have appointed a committee to inquire into and report on the desirability of electrical communication between light-vessels and the shore, with the special object of facilitating the saving of life at sea.

The production of Bessemer steel ingots for last year was 1,570,520 tons, against 1,304,127 tons in 1885. The make of Bessemer steel rails was 730,343 tons against 706,583 tons in 1885.

The machine guns now in use in the service fire a special cartridge, but when the new small-bore rifle has been introduced, the machine guns will be adapted to the same bore, and the cartridges for both will be identical.

Last week at a rolling mill in Marchiennes, Belgium, a flywheel, weighing about 90,000 kilogrammes, broke, and split a second flywheel, and the two wrecked the iron roof of the building, causing great havoc. Three workmen were killed and 35 severely hurt.

A boiler explosion took place at Kettering last week on the premises of a coach-builder. The boiler belonged to an engine which was used for steam sawing. The forge and the workshops were demolished, and a shed at some distance from the boiler was reduced to ruins.

The military authorities have decided that for active service solid drawn cartridges will alone be issued; but for practice ammunition there are advantages in the rolled metal cartridge case which justify the continuance of its manufacture and issue.

The Post Office received during the year 1886 on account of Anglo-French messages the sum of 37,906*l.* The total earnings of the Post Office under the joint purse arrangements with the Submarine Telegraph Company were for the same year 132,223*l.*

The Cantor lectures on "Friction," by Professor Hele Shaw, of University College, Liverpool, have just been issued in a cheap pamphlet and form a complete exposition of the subject. They are published by W. Trounce, 10, Gough-square, E.C.

Mr. A. E. Garwood, Mem. Inst. C.E., late engineer-in-chief to the locomotive and carriage department of the Egyptian Government Railways, has joined Mr. Q. A. McConnell and Mr. George Lowthian in the firm of Messrs. Q. A. McConnell and Co., of 35A, Great George-street, Westminster.

The shock of the earthquake in the Riviera was felt and recorded by an instrument, the bifilar magnetograph, at Kew Observatory on Friday morning at 5 hrs. 40 min. Greenwich mean time. There were indications of the later movements also recorded, but they could not be traced with certainty.

The gross receipts of the twenty-two principal railways in the United Kingdom, for the week ended February 20, amounted, on 15,381¾ miles, to 1,068,892*l.*, and for the corresponding period of 1886, on 15,257 miles, to 1,070,097*l.*, an increase of 124¾ miles, or 0.8 per cent., and a decrease of 1205*l.*, or 0.1 per cent.

Lord G. Hamilton states the Sir W. Thomson's deep-sea sounding machine is only supplied to the larger types of ships and to vessels with very high speed. Certain improvements in the machine have been suggested and are under trial. Until these are completed there is no intention of extending its issue to the smaller classes of ships.

A serious accident occurred on Monday at the Dowlais Steel Works. Some men were at work in the pit of the Bessemer department, and a molten mass was being emptied from the ladle into the mould, when an explosion took place, the cause of which was not ascertained definitely, but was thought to have arisen from the presence of water in the mould. Four men were seriously burnt.

The shears at Pembroke Dockyard are "obsolete and decayed so that they will not lift the boilers and machinery for vessels now building there. The cost of replacing them would, the First Lord of Admiralty says, be very considerable," so the Admiralty do not feel justified in incurring the expense. Ships therefore will be towed to Portsmouth.

The Aldershot Gas and Water Works Company, having to increase their water supply, are having another artesian bored tube well sunk by Messrs. Le Grand and Sutcliff, of London, 250 ft. deep and 7¼ in. bore. This makes the fourth tube well of the series which will have been put down, the entire supply for these works being obtained from the tube well system.

The British Iron Trade Association Report states that the make of pig iron in 1886 was 6,870,665 tons, against 7,250,657 tons in 1885. This is the smallest make of any year since 1879, when the production was 6,009,434 tons. The production in other countries, so far as at present known, was also smaller in 1886 than in 1885, except in the case of the United States, which show an increase.

The steel produced at the Government factories at Woolwich during the last three years has been as follows: In 1883-4, 1564 tons; in 1884-5, 1698 tons; in 1885-6, 2279 tons. The heaviest single casting in each of the first two years was about 19 tons, and in the last year about 12 tons. During the coming financial year it is proposed to give to the trade nearly three fourths of all the gun forgings which may be required.

A supplementary naval estimate was issued on Tuesday, from which it appears that an additional sum of 277,000*l.* will be required, bringing the total vote for the year up to 13,270,100*l.* Of the additional sum, 105,000*l.* will be appropriated under the head of machinery and ships built by contract; naval stores, 79,000*l.*; conveyance of troops, 76,500*l.*; medicines and medical stores, 5500*l.*; Admiralty Office, 3500*l.* and miscellaneous services, 7500*l.*

The members of the Association of Birmingham Students of the Institution of Civil Engineers, held their fortnightly meeting at the Colonnade Hotel last night, the President (Mr. E. Pritchard) in the chair. A paper was read by Mr. Alfred Hill (West Bromwich) on "Water Works and Water Supply," in which he described the ancient and modern methods of sinking wells and deep borings, also the construction of water towers.

The Executive Commissioners of the Melbourne Centennial International Exhibition have issued a circular stating that the Exhibition will be opened on August 1, 1888, for six months. It is requested that applications for space may be made before the end of August this year. The space will be free, and the motive power free. The Commission desires to make the Exhibition specially interesting in manufacturing processes, machinery, &c., in motion, and objects of manual labour, &c.

The New Zealand newspapers just to hand report a competition at Blenheim on January 7 between the English and American sheaf-binders. The following is an extract from the *Christchurch Press* of January 11: "Six machines entered, three Hornsby (English), a McCormick (American), a Deering (American), and a Howard (English). The crop of oats was of a very heavy character; so heavy, in fact, that the agents of the McCormick and the Deering after viewing it withdrew their machines from the competition. The judges awarded the Howard machine first place, basing their decision on the general excellence of the work.

The prospectus of the Hotchkiss Ordnance Company, Limited, is before the public. It announces that the business carried on by the late Mr. B. B. Hotchkiss has been bought by Mr. Bronson Willett, who has transferred it to a limited company. The share capital is fixed at 800,000*l.*, with 300,000*l.* in 5 per cent. mortgage debentures. The profits of the last three years have amounted to nearly half a million sterling, those of 1886 being 185,000*l.* Assuming the future annual profits to be 160,000*l.* this will pay (1) the interest of the debentures, and will redeem the principal in fifteen years, (2) 7 per cent. on 35,000 preference shares, and (3) 20 per cent., or 45,000 ordinary shares of 10*l.* each. The price paid to the vendor is 1,050,000*l.*, of which 55,000*l.* will be in shares. The works at St. Denis, Paris, employ 700 to 800 hands; Sir William Armstrong, Mitchell, and Co., in England, and the Gruson Verk, in Germany, also manufacture the Hotchkiss guns. The subscription list will close on or before Monday next.

BELGIAN STEEL RAILS.—The exports of steel rails from Belgium last year amounted to 38,463 tons. The corresponding exports in 1885 were 56,822 tons; and in 1884, 64,650 tons.

MACHINERY FOR DRESSING COPPER ORES; LAKE SUPERIOR DISTRICT.

(*For Description, see Page* 215.)

Fig. 11.

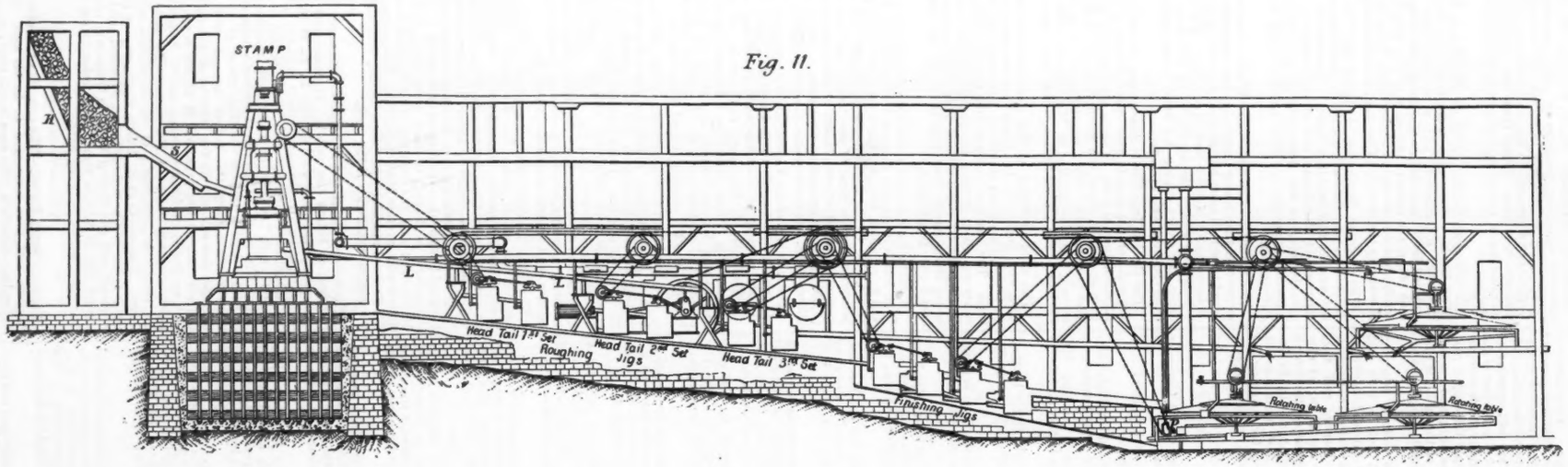


Fig. 12

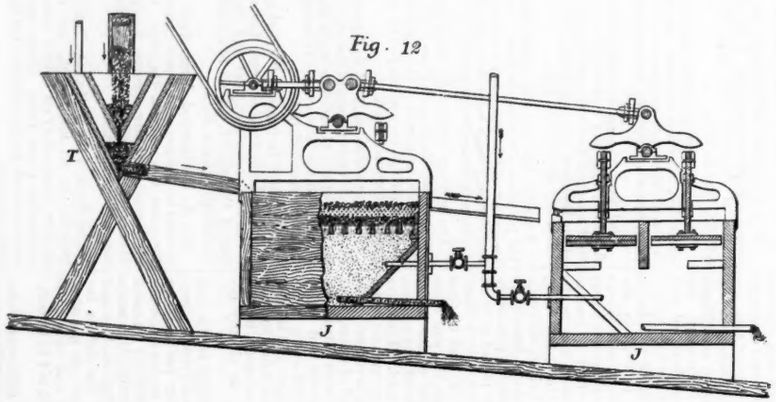


Fig. 13.

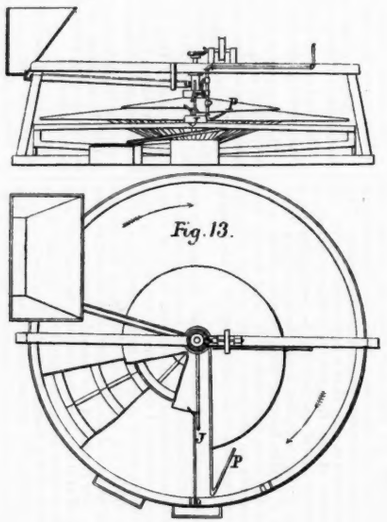


Fig. 14.

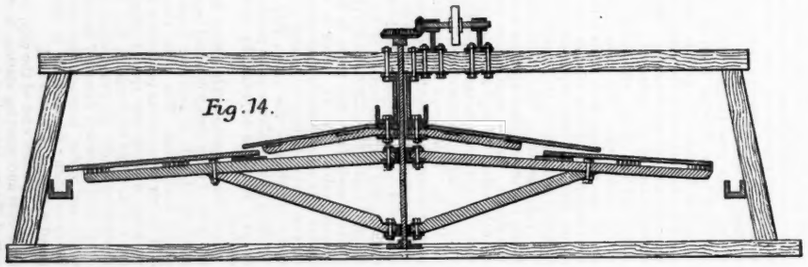


Fig. 15.

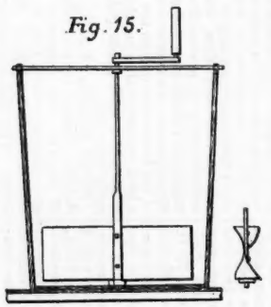


Fig. 16.

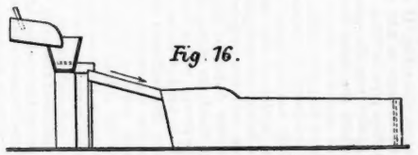
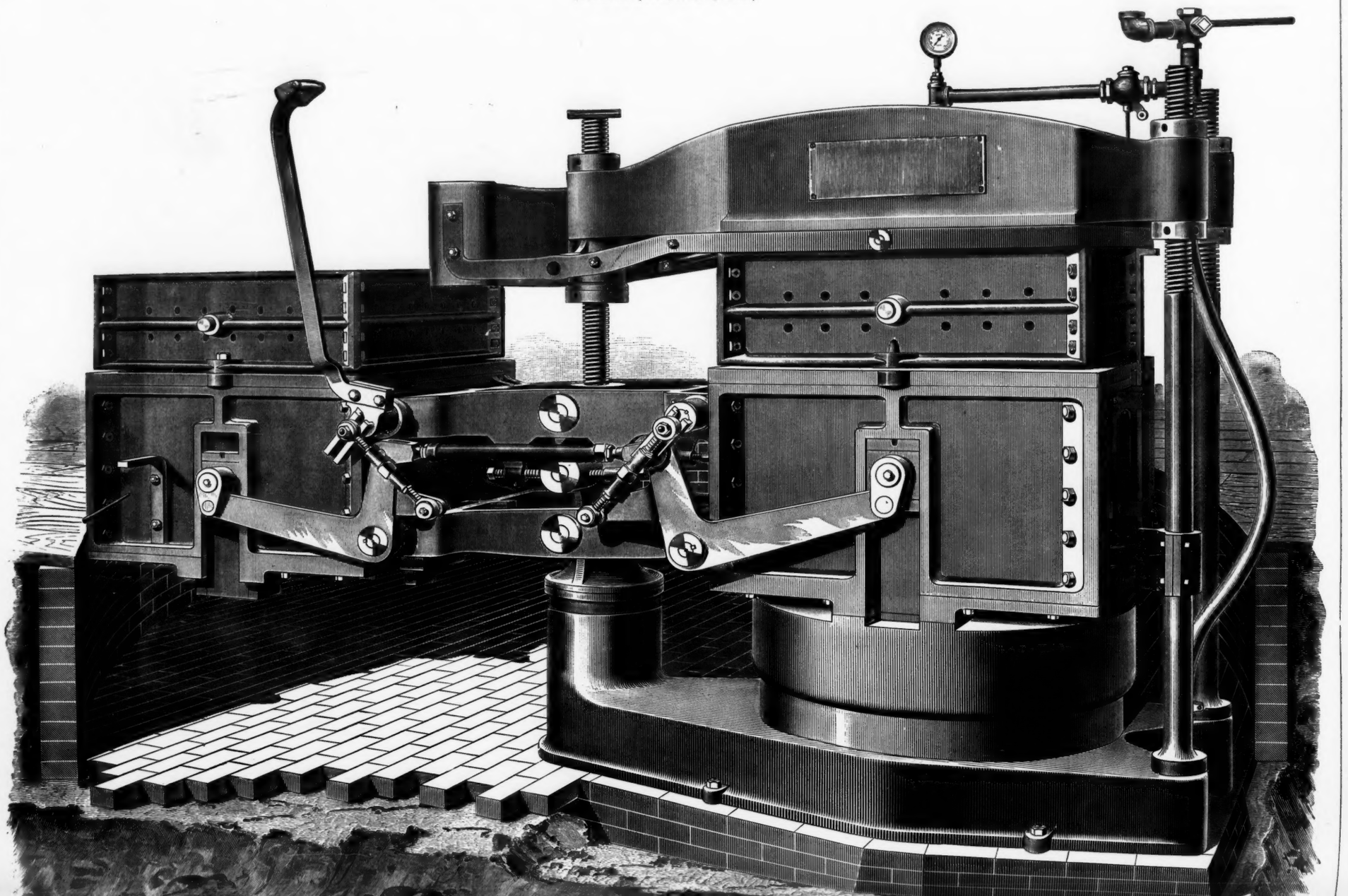


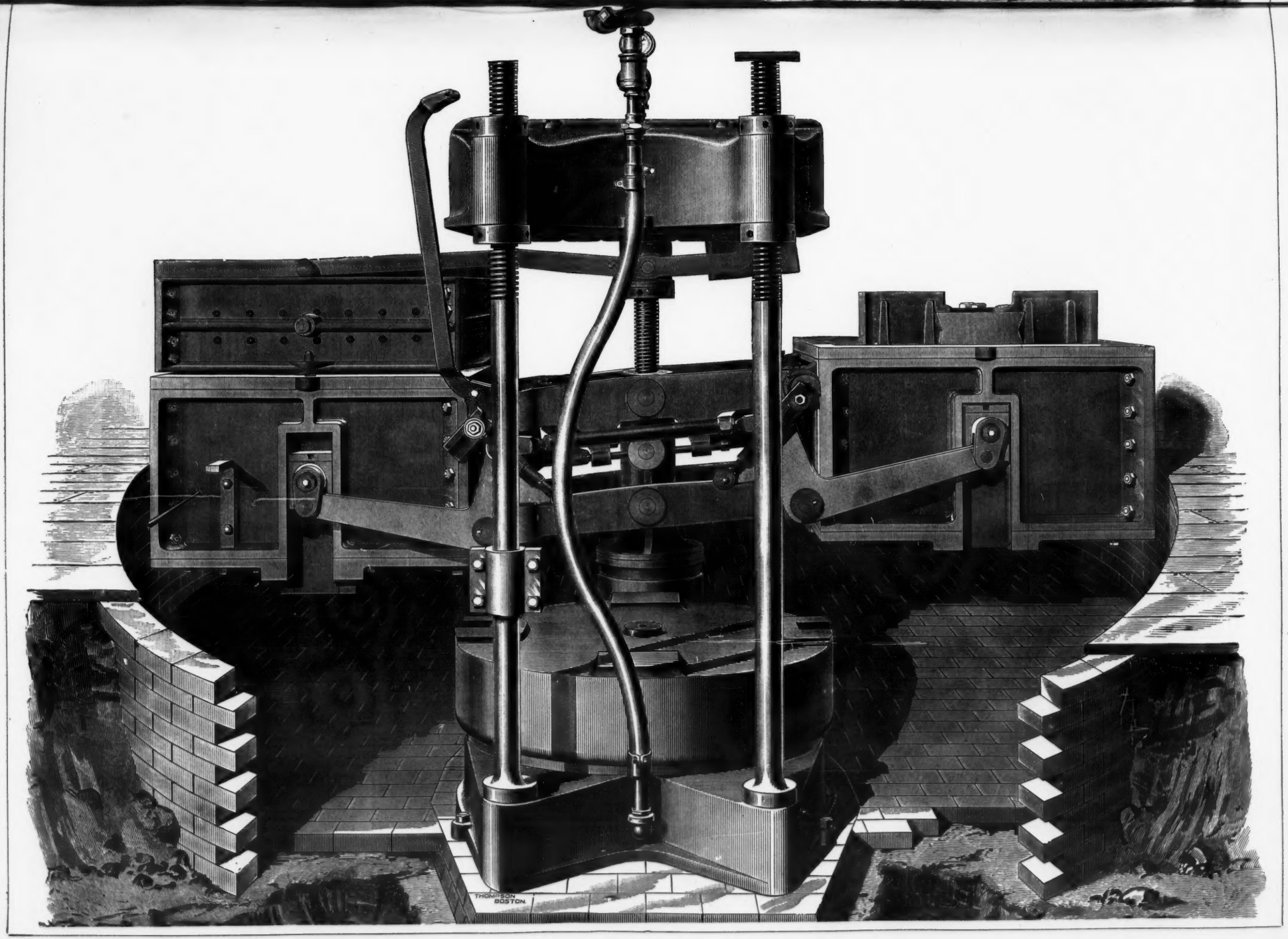
Fig. 17.

PNEUMATIC MOULDING MACHINERY.

CONSTRUCTED BY THE PNEUMATIC COMPANY, INDIANAPOLIS, IND., U.S.A.

(*For Description, see Page* 203.)

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With a Two-Page Engraving of PNEUMATIC MOULDING MACHINERY.

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Students' meeting, Friday, March 4th, at 7.30 p.m. Paper to be read: "Propelling Machinery of Modern Warships," by Sydney H. Wells, Wh. Sc., Stud. Inst. C.E.—Ordinary meeting, Tuesday, March 8th, at 8 p.m. Paper to be further discussed: "Dredging Operations and Appliances," by John James Webster, M. Inst. C.E.

GEOLOGISTS' ASSOCIATION.—Friday, March 4th, when the following paper will be read: "A Revision of our Lower Eocenes," by G. F. Harris, F.C.S., &c. The chair will be taken at 8 p.m.

THE SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Meeting on Thursday, March 10th, at 8 p.m. "Reversible Lead Batteries and their use for Electric Lighting," by Desmond G. Fitzgerald, Member.

SOCIETY OF ENGINEERS.—Monday, March 7th, at the Westminster Town Hall. A paper will be read on "Bridge Floors; their Design, Weight and Cost," by Mr. E. Olander, A.M. Inst. C.E. The chair will be taken at 7.30 p.m. precisely.

SOCIETY OF CHEMICAL INDUSTRY.—Burlington House, Monday, March 7th. "M. Hermite's System of Electrolytic Bleaching," by Messrs. Cross and Bevan. 1. "Castner's Sodium Process," 2. "A new Method of Elevating Liquids specially applicable to Acids," by Mr. Jas. Mactear. The discussion will be taken on April 4th.

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—Saturday evening, the 5th inst., at the Cannon-street Hotel, at 7.30 p.m., for transacting the ordinary routine business, after which Mr. Henry Stokoe will report his recent visit and experiences at the anniversary meeting of the Manchester Association of Engineers. A paper will then be read by Mr. Walter Swanson, late chief engineer of the s.s. Inverleith, on "The Modern Marine Engine and Boiler."

ENGINEERING.

FRIDAY, MARCH 4, 1887.

THE RAILWAY AND CANAL TRAFFIC BILL.

IT will be remembered that previously to the Parliamentary session of 1885 nine railway companies deposited Bills having the object of producing "a uniform classification and simplified system of charges" on goods traffic.* The trading community, however, took alarm at the proposed simplification, which they foresaw would end in a levelling up rather than a reduction of freights, and they entered upon an agitation which resulted in the Government taking up the entire matter and in the private Bills being shelved. Accordingly Mr. Stanhope, for the Board of Trade, drafted a Bill which was immediately denounced at every meeting of shareholders in the kingdom as the most barefaced confiscation and judicial robbery of private rights. The course of political events prevented this Bill being proceeded with, and last year the matter came into the hands of Mr. Mundella, who, practically following the lines of his predecessor, presented the scheme before Parliament. Here, however, the railway directors assumed quite a different attitude from that which they had borne in the Board-room, and allowed the second reading to pass without a division, contenting themselves with criticism, and with the hope of getting amendments made in their favour in committee. Again the strife of party politics befriended them, and the Bill eventually met its fate among the other innocents at the end of an eventful but fruitless session.

This year the Bill has again reappeared. From a political point of view it bears a decided neutral tint, having already marched both under Conservative and Liberal colours, and now being again accepted by the former party. Further, as last year it passed its second reading without opposition, it may be expected that it will now float by an easy course into an Act of Parliament, subject only to the attempts which the railway interests may make to rob it of some of its power when it comes to be discussed clause by clause. As many may have forgotten the past Bills, which, moreover, were not quite identical with the present, we will give a brief summary of its more important features.

The Railway and Canal Commission established by the Regulation of Railways Act, 1873, is to be abolished, and to be superseded by another, clothed with wider powers to regulate the rates charged for traffic on railways and canals. The Commission will consist of three permanent members, and the *ex officio* members, one for each country of the realm. The three permanent members are to consist of a lawyer, of a layman experienced in railway matters, and of a third, whose qualification is not specified. The *ex officio* members are to be judges, and one of them will always preside in cases of importance. The Commission will have jurisdiction to determine complaints of contravention by the companies of Private Acts of the same nature as the complaints which they entertain under Public Acts. They will be empowered to settle disputes concerning tolls and rates, to order reasonable traffic facilities, even if they be contrary to agreements entered into by companies, to award damages, and to settle various other points. It is an important feature of the proceedings of the new tribunal that an action can be commenced before it by bodies and associations who are not aggrieved by the matter complained of. Harbour boards, municipal councils, county boards, quarter sessions, and rural authorities may make complaint, as may also associations of traders and freighters if they can obtain from the Board of Trade an expression of opinion that they are "proper bodies" for the purpose, that is, we suppose, that they are *bonâ fide* representative institutions. By this arrangement the task of fighting powerful railway corporations may be transferred from individuals to chambers of commerce and trade societies, and thus many of the smaller wrongs which are borne by freighters, because it pays no one to fight them, will be rectified by the combined action of a class.

It is not probable that the part of the Bill referring to the Commission will evoke much opposition, as the companies are already familiar with such a tribunal, and are aware that while it commands the respect and approval of the public, it does not press unduly on themselves. It will be around the second part of the Bill, concerning traffic charges, that the battle will really rage, for it is here that the sacrifices on the part of the railway interest will have to be made. Unless the effect of the proposed changes is to reduce the burden of transport which has been felt so heavily during the present spell of low prices, the Bill is not what is wanted by the public; readjustment of rates and the fixing of demands which are now irritating from their uncertainty, will do much to settle matters between the companies and their customers, but of themselves they are not enough, and a substantial reduction is needed in many classes of heavy goods to enable us to compete with the foreigner who enjoys the advantages of a cheaper transport than our own.

Clause 24 of the Bill goes to the root of the matter by sweeping away all existing classifications and scales of charges, and by providing for the creation of a new set; whether these will, or will not, be the copy of the old ones, remains to be seen. The Bill states that "every railway company shall submit to the Board of Trade a revised classification of merchandise traffic, and a revised schedule of maximum rates and charges applicable thereto, proposed to be charged by such railway company, and shall fully state in such classification and schedule the nature and amounts of all terminal charges proposed to be authorised in respect of each class of traffic, and the circumstances under which such terminal charges are proposed to be made." It will be possible for persons who have objections to urge against the proposed charges to lodge their complaints with the Board of Trade, who will then endeavour to reconcile the various interests, and will propose a schedule and classification for the acceptance of each company, using all reasonable endeavours to effect an amicable agreement. If the Board succeed in this, the matter will then be embodied in a Provisional Order, and be subsequently confirmed by an Act of Parliament, "of which," by a touch of irony, "the railway company shall be deemed to be the promoters." If the company will not accept the Board's schedule and classification, the matter will be reported to Parliament, and the contested points will apparently—for this point does not seem very clear—be fought out before a Select Committee. Thus the Board of Trade, while it has no power to determine rates, will have an immense amount of influence, and if the matter comes before a Committee the whole weight of the Board's experience and authority will be cast against the companies, who will find this a much more serious feature in the decision than the opposition of isolated traders. The Board will decide between the public and the company, and if the latter reject the decision, a Select Committee will arbitrate between the company and the Board.

The next clause relates to a matter of great difficulty, and one which deeply stirs the public mind, namely, preferential rates. It sets forth whenever it is shown that a company charges one class of traders lower rates than it charges to another class of traders, or that there is a difference in the treatment of British and foreign goods, or a difference in goods founded on the place of origin, "the burden of proving that such lower charge or difference of treatment does not amount to an undue preference shall lie on the railway company." This appears to hold out good grounds of hope to manufacturers and agriculturists on the coast, who see foreign goods landed and conveyed to inland towns for a mere fraction of the sums demanded from them for the same service. One would think that the companies would find it hard to prove the justice of their dealings in carrying garden and dairy produce from France to London for far less than they will carry it from Kent, so that the native grower finds it cheaper to let his fruit rot on the ground while the foreigner reaps a profit in spite of the distance. But when we come to the instructions to the Commissioners in deciding what amounts to undue preference, it appears doubtful whether the new rule will work

* Vol. xxxix., page 115.

any improvement. The Commissioners are informed that in addition to any other question they may "take into consideration whether such lower charges or difference of treatment is necessary for the purpose of securing the traffic in respect of which it is made." Surely nobody supposes that railway companies give preferential rates to the foreigner, or to any one else, out of pure benevolence, or that they charge a farthing less than they can help. Their demands are generally fixed by the competition of water carriage, and the complaint of the inland trader is that the railways carry goods at rates which injure the home trades and do their shareholders no good. Some companies appear unable to bear the idea of traffic escaping them, and rather than miss it they will take it at a loss. In our opinion this practice should be stopped, and all rates which will not pay working expenses should be considered preferential. By working expenses, we mean those charges which are due to the traffic itself, but not interest on capital, or expenses which do not vary with the weight or bulk of goods carried. It would be manifestly unjust to prevent a line earning small profits on any given class of traffic for a certain place, if it can be shown that no greater gain can be secured. Neither would it be right to insist that all goods of that class, from whatever origin, should be carried at a rate fixed by water competition, for that would end in the bankruptcy of the undertaking. But it is most desirable that the mad eagerness for traffic at any price should be discouraged, and that commercial interests should not be imperilled in order that railway managers may show large totals, and that there may be plenty of work for their clerks and employés.

Another point which needs correction on lines carrying Continental traffic—and it is these lines which sin the most in the way of undue preference—is the custom of making the goods traffic bear the cost of attracting passengers. The public demand large and swift boats, and the companies vie with each other in supplying them. These boats must have cargo at whatever price it is obtained, and if the railway undertakes the sea transit, it must also carry the goods forward to their destination. For perishable articles the superior speed of passenger boats and trains will command higher rates than would be paid if the entire transit be made by sea, but a large cargo of fruit and dairy produce cannot be secured every day, hence the hold must be filled with heavy goods which are transferred to rail and carried at a price which involves absolute loss to the company, and ruin to English traders who do not share in the gains of the passenger traffic which is nursed in this manner. The companies may easily plead that their charges are necessary to secure the traffic, but the Bill ought to make it quite clear that it is not necessity of this kind which is to be admitted in justification of "preferential rates."

After this point is disposed of, there follow clauses providing that places in the same district may be grouped together, and charged uniform rates; and that persons aggrieved by unjust charges may complain to the Board of Trade, and that if the complaint be reasonable the Board will mediate between the parties. The portion of the Bill relating to canals brings them under the same conditions as railways. They are to send to the Board of Trade returns giving particulars of their company, works, tolls, capital, and so on. They are also to send their bye-laws for confirmation, and are strictly forbidden to be bought up by money supplied by railway companies. The Act ends with a series of miscellaneous clauses relating mainly to matters of procedure.

With certain exceptions which we have pointed out, we think the Bill will give satisfaction to the mercantile community. In the first place it provides for a new schedule and classification in the production of which all representative bodies may be heard, and if many of the present oppressive charges are not abolished only the freighters will be to blame. Terminal charges, also, are to be fixed, and a very serious bone of contention be removed in this particular. The proceedings before the Commissioners will be prompt and easy, and the sittings may take place in any part of the country to accommodate the litigants. Finally, any one can invoke the kindly office of the Board of Trade, and thus the private individual who formerly was powerless in the hands of a great corporation, acquires the assistance of a powerful ally pledged to secure fair dealing.

DIAGONAL JOINTS FOR BOILERS.

We have published a number of letters recently which show that there is a great diversity of opinion as to what the strength of a diagonal seam of a cylindrical boiler is, relatively to the same seam placed longitudinally. If the ends of such a boiler were tied to each other by longitudinal stays so numerous that they bore the whole of the pressure upon the ends, the cylindrical shell would become merely a hoop sustaining a radial pressure only, and the stress on the shell plates would be wholly circumferential. In this case a 45 deg. diagonal seam would be $\sqrt{2}$ in length for every unit length of shell, and the relative strength would be $\sqrt{2} \div 1 = 1.414$. Two of our correspondents have claimed that this would be the relative strength in actual boilers. To insure that it would be so, not only must the stays be put in sufficient for the whole longitudinal tension, but it must be made certain that the tension is wholly on the stays, and none of it upon the shell plates. The letter of Messrs. Rollo and Son, and that of Mr. Hartland, calculate the strength in this way to be proportional to the secant of the angle which the direction of the seam makes with the longitudinal direction. Under the special condition named, no doubt, this would be the correct way to calculate the strength. We believe, however, that hitherto neither Lloyd's nor the Board of Trade have ever intended to take longitudinal stays as a set-off for a reduction in the longitudinal strength of the shell. These stays have been put in only to prevent the buckling of the end plates.

In cylindrical boilers of the usual construction the seams are longitudinal and circumferential. At every longitudinal seam we have both a transverse stress and a longitudinal stress acting, but the transverse stress alone has to be considered, because it alone exists between the two plates united by the seam. The longitudinal stress there is a tension balanced in each plate; it does not cross a longitudinal seam. Conversely the longitudinal stress alone is transmitted across a circumferential seam, while the transverse stress is in each of the plates a balanced tension which does not cross the seam, and is therefore not an element in the calculation of the strength of that seam.

We hold that if the structure is sufficiently stayed longitudinally, the strength of a diagonal seam would be properly calculated as our two correspondents just named, do it. If, however, we were asked to take upon ourselves the responsibility of recommending a departure from the present practice, which gives by calculation a great surplus of longitudinal strength, we should have some hesitation in doing so. In large marine boilers there is frequently a working of some of the lower circumferential seams owing to the unequal temperatures and the consequent unequal expansion of the upper and the lower parts of the boiler, and it lessens the alarm one might otherwise feel to remember that there is a very great excess of strength in boiler shells longitudinally. Neither of our correspondents has introduced the action of the longitudinal stays into the question as an element to be considered; we shall therefore at present also neglect them. The Board of Trade seem to have been fully alive to the importance of these stays when they made it a condition that the proposed test boiler should have no longitudinal stays.

Upon a 45 deg. diagonal seam extending 1 ft.

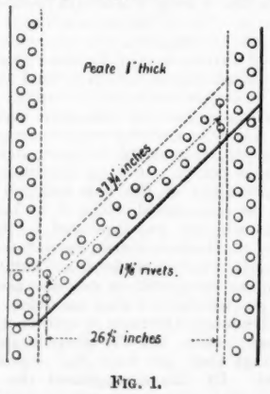


FIG. 1.

longitudinally and 1 ft. circumferentially we have to consider what the actual stress is. Let the joint be as in Fig. 1, Messrs. Rollo's diagram. In Fig. 2 denote the force on A C of longitudinal seam by B C, and the force on B C of circumferential seam by B K, that is, make B K = half of B C. The resultant or force representing all the force on B C along with all the force on A C is represented by the line C K whose length is $\sqrt{1\frac{1}{4}}$, calling A C and B C each unity. This is

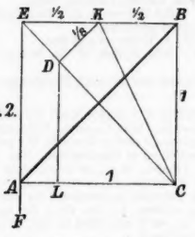


Fig. 2.

clearly the resultant of all the forces acting on the triangular piece of plate A C B, and therefore all that can affect the seam supposed to be at A B. This resultant force, if divided over the length A B, gives $\sqrt{1\frac{1}{4}} \div \sqrt{2} = \sqrt{\frac{5}{8}} = .79$ and $100 \div 79 = 1.26$, say, given by Mr. Robert Cory, as the relative strength of the diagonal seam.

The acting resultant force is oblique to the direction of the joint. The joint can fracture in its own line by the parts opening perpendicularly to the direction of the joint. In doing so, only C D, the component of the resultant which is normal to the direction of the joint, would be effective. The other component, D K, would act parallel to the joint, pulling on B C. That is, it cannot act but by a movement in its own direction, and that motion is opposed by B C. What the diagonal seam has to resist is therefore only that part of the resultant which is normal to itself or $\sqrt{(B C^2 + B K^2 - D K^2)} = \sqrt{(1 + \frac{1}{4} - \frac{1}{8})} = \sqrt{1\frac{1}{8}}$ instead of $\sqrt{1\frac{1}{4}}$. This divided over the length of the joint, viz., $\sqrt{2}$, gives $L C = \sqrt{1\frac{1}{8}} \div \sqrt{2} = \sqrt{\frac{9}{16}} = \frac{3}{4} = 75$ per cent., and $\frac{100}{75} = \frac{4}{3}$ the strength ratio quoted in the letter of "Boilermaker and Sons."

If the diagonal seams extended spirally the whole length of the cylindrical shell, there would be then less reason for distinguishing between the normal and the tangential stress, and the Board of Trade and Lloyd's might then make the strength ratio to be only 1.26 as given by Mr. Cory. There is really no difference amongst our correspondents; it all depends upon the conditions assumed. The intensity of the normal component of the resultant for any inclination of seam is calculated thus: Let the seam rake so as to measure n circumferentially for 1 longitudinally. In Fig. 3 make A C = C H = 1, make

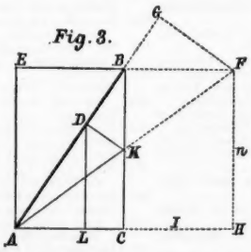


Fig. 3.

C B = n. In this diagram we shall get the force lines at right angles to what their true directions are. By comparing with Fig. 1 it will be seen that the process is, however, quite identical. To avoid fractions we have extended the diagram in dotted lines. The total resultant is A K, the normal resultant is A D, and its intensity per unit of length of seam is A L, not at right angles to its direction. It is evident that A D = half of A G.

$$A L = (H F^2 + A H^2 - G F^2)^{\frac{1}{2}} \div 2\sqrt{(1 + n^2)}$$

or

$$A L = \left\{ n^2 + 2^2 - n^2 \div (1 + n^2) \right\}^{\frac{1}{2}} \div 2\sqrt{(1 + n^2)}$$

$$= \frac{n^2 + 2}{2 n^2 + 2},$$

the resultant stress as given by "Boilermaker and Sons," or the strength ratio is

$$\frac{2 n^2 + 2}{n^2 + 2}.$$

The method of the ellipse of stress as given by

Rankine can now be compared with the above; it will be found to be practically the same. The intensity of transverse stress is, say, 100 = O X; the intensitity of the longitudinal stress is then 50 = O Y. The half of the sum of the two is 75 = O M. The direction is the seam is O D. Describe a semicircle about O with radius O M. Draw O M perpendicular to the direction of the seam. With the same radius, O M, about M strike the points P and Q. Because P O Q is a right angle therefore P M Q is a straight line. Set off, towards the greater stress, M R = half the difference of the two stresses, that is $\frac{100-50}{2}=25$. Join O R; this is the resultant intensity of the stress, 79, and the direction in which it acts. Draw R D parallel to O M, then D R is the resultant normal intensity. When the point R is found for different rakes of joint, its locus is the ellipse of which Y X Y¹ is one-half.

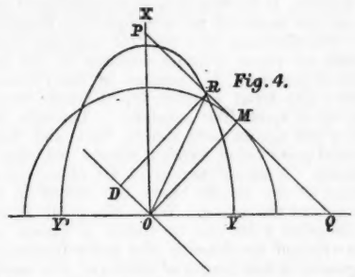


Fig. 4.

MAGAZINE AND REPEATING RIFLES.

THE theatre of the Royal United Service Institution was densely crowded on Friday afternoon, the 25th ult., to hear Captain James lecture on the question which at the present moment excites so much attention in all the military circles of Europe.

In his opening statement, the lecturer asks what it is we seek to obtain from the magazine or repeating rifle. Surely the rapidity with which a good form of single-loader can be fired will suffice. With the Soper rifle forty-three well-directed shots have been fired in a minute, and what more can be desired or required in war? But this argument does not really deal with the true reason for their introduction. As stated by Captain James himself in the same place seven years ago, "The future undoubtedly lies with repeating rifles; the advantage of this form of weapon is that it enables a *sudden* shower of bullets to be poured in at a moment when increased intensity of fire will decide the victory." This blinding rain of bullets at a critical moment is to be obtained from the magazine rifle alone, and it is for this reason that the nations of Europe are spending millions of money in the re-armament of their troops. There is also the second advantage of the confidence and moral support given to the soldier, who feels that he has a reserve of power constantly at hand.

In a properly constructed magazine rifle the time taken to convey the cartridge from the pouch and press it into the bore is eliminated. Drawing back the action cocks the rifle, throws out the empty case, and brings the fresh cartridge to the mouth of the chamber, while the act of closing the breech presses it home.

Conceive for a moment the effect, when of two lines holding one another in close action, one is suddenly enabled to quintriple its fire rate. To sentries, also, and small reconnoitring parties of cavalry, the repeating rifle would be of the greatest assistance. In the American civil war it was said that one man armed with the Spencer was equal to five with the ordinary muzzle-loader, while in the Russo-Turkish war the Winchester did good service to the Turks.

The lecturer reviewed the measures taken by the European powers to provide an efficient magazine rifle for their armies. As usual, Germany was in the van of progress—at least, in order of time. Immediately after the war of 1870-71, experiments were commenced — or rather, resumed — which resulted in the needle-gun being superseded by the Mauser rifle model "M 1871." A few years later, endeavours were made to increase its rapidity of fire, and it seemed at one time likely that the heavy Löwe magazine, which is of a horseshoe shape encircling the breech, would be adopted, but its clumsiness prevented its introduction. After various trials, the Mauser magazine rifle was adopted. It is now in the hands of five army corps, and probably before the summer will be the weapon of the whole German army. As the name "M 71-84" indicates, it is the breechloading rifle of 1871 with the addition of a magazine under the barrel and a mechanism for raising the cartridges to the chamber. The magazine holds eight cartridges, which with one in the "elevator" and one in the chamber, makes ten in all. By pushing forward a stop on the left side the magazine action can be shut off, and the rifle turned into a single-loader. The cartridge is the same as for the M 71 weapon, but experiments have been made with an increased charge of compressed powder, and a lead bullet with a thin covering of steel; this would raise the muzzle velocity, increase the penetration, and make the trajectory flatter. But this rifle is faulty in having the magazine under the barrel; when filled it is a very heavy awkward weapon, and the balance is altered each time it is fired.

In France no definite solution has yet been arrived at, but the Lobel-Gras repeater will probably be adopted, having eight cartridges in a magazine under the barrel, and—in the case of new arms—a reduced bore of about 0.307 in. The French Navy have for some years been armed with the Kropatschek magazine rifle, which does not materially differ from the Mauser, except in being rather more complicated; the magazine can hold seven cartridges.

Austria has definitely adopted the Mannlicher rifle, which presents two peculiarities worthy of special notice. The Werndl barrel and ammunition is retained, but the block for closing the breech has been replaced by a very ingenious bolt, which is opened and closed by a straight backward and forward motion; this can be worked much more quickly than one in which there is also a side turn for locking the bolt, and the rifle need not be removed from the shoulder till the magazine is empty. The cartridges are carried by the soldier packed in small tin frames holding five rounds; one of these frames is placed in the magazine, which is situated under the shoe or bolt chamber, whence the frame falls automatically when empty. The frame weighs about the same as a bullet, 385 grains, and costs less than a halfpenny. The rifle cannot be fired as a single-loader when these frames are used. This arm appears very superior to the Mauser; like that rifle and the French Kropatschek its calibre is 0.433 in.

In Italy, it has been determined to alter the Vetterli bolt-gun system known as the Vitali. A magazine is fixed under the shoe, in front of the trigger guard, into which four cartridges packed in a cardboard box are pushed from above. This is avowedly only a temporary expedient, pending the introduction of an improved weapon; the alteration costs a very small sum. Like the Mannlicher this rifle cannot be used as a single-loader.

Switzerland has for some years past had the Vetterli magazine rifle, with a rather complicated action, somewhat on the Winchester principle; the magazine under the barrel holds eleven rim-fire cartridges; the arm is very heavy, weighing 10 lb. 8 oz.

Russia has introduced the Evans rifle into her navy, which carries the very large number of thirty-five cartridges in a magazine in the butt, but is not likely to be adopted in the army. Pending the introduction of a new arm, it is stated that a form of attachable magazine has been devised for the Berdans, which can be fixed to that rifle in less than ten minutes.

Sweden has for some time had the Jarman magazine rifle. At first the magazine was a box affixed to the right side of shoe at an angle of about 30 deg. to the vertical, but this has been replaced by a tube under the barrel holding eight cartridges. A specimen of the original arm was exhibited.

Portugal has recently adopted a magazine arm, the Guèdes rifle, distinguished from all the others mentioned by a small bore, 0.323 in., and high initial velocity. The magazine and breech action are the same as in the Kropatschek.

As regards our own country, it has been resolved to manufacture a limited number of two of the magazine rifles which have been experimented upon by the special committee appointed by the War Office, and to issue them to the troops for an extended practical trial, before definitely adopting a new pattern for the whole army. These are the "improved Lee" and the "Lee-Burton," which were placed at the disposal of the lecturer by the kindness of the Secretary of State for War. The former has the Lee box magazine under the breech, in front of trigger-guard, but it is fixed instead of being detachable as in the original Lee repeater. The "Lee-Burton" has the magazine fixed to the right side of the breech, and therefore not so much out of the way as in the Lee.

The lecturer exhibited and explained the action of the above rifles, excepting those adopted by France and Russia, as well as the Pieri, the Schulhof, Owen-Jones, Bethel-Burton, and Winchester magazine guns. The Pieri, with a calibre of 0.323 in., like the Portuguese Guèdes, is said to give a muzzle velocity as high as 2057 ft. per second. The Schulhof has a central magazine holding ten rounds, and like the Mannlicher, a straight bolt action. The Owen-Jones is distinguished as being the only block-action magazine rifle exhibited, which is worked by a simple backward and forward motion under the stock.

The fixed magazine is preferred by the lecturer to the detachable, as less liable to be lost in the heat of action, when also it would be difficult to affix fresh magazines.

Captain James dwelt upon the chief desiderata in the most improved form of military rifle. Putting aside the great questions of simplicity and durability of mechanism, it should first shoot well and closely up to 1500 or 2000 yards; secondly, have a flat trajectory within the decisive fighting zone of say 600 yards. These two conditions require:

A. A high proportion of weight of bullet to its area of cross-section (*i.e.*, $\frac{D^2}{W}$ to be kept as low as possible).

B. A high muzzle velocity.

To fulfil these conditions without unduly increasing recoil, or the weight of the rifle, it is necessary to have a long light projectile, or, in other words, a small bore is a necessity. Experiments in this direction have been followed out by Lieutenant-Colonel Bode in Germany, and Major Rubin and Professor Hebler, in Switzerland. They have likewise all determined that a lead bullet covered with a thin shell of harder metal—copper or steel—is far preferable to lead alone. It is claimed that this projectile does not lead the grooves, as is likely to be the case with a long soft projectile driven at a high speed; nor does it wear the rifling, as would a bullet of hardened metal, the thin steel or copper coating being pressed into the lead of the bullet. The former seems preferable, and a Hebler rifle has fired 1500 rounds with steel-coated bullets without the least sign of wearing the rifling. The steel envelope polishes out the bore every time, and removes fouling, so that no lubricator is required. Tables were exhibited showing the remarkable results of firing this projectile; fired from the Mauser rifle it penetrated through two blocks of beech-wood each 3½ in. thick, and eleven deal planks.

The lecturer said he would like to see trials made in this country of calibres smaller than the new Enfield-Martini barrel of 0.4 in. The diagrams of trajectories exhibited showed this rifle to have a flatter trajectory than any European military arm, except possibly the Guèdes, but Professor Hebler's rifle slightly beat it in this respect, being quite 2 ft. lower at its highest point, which was about 30 ft. in a range of 1000 yards. He suggested a bore of 0.32 in., with a bullet of 336 grains, and a powder charge of 90 to 100 grains as a desirable combination.

To the objection usually made that long bullets from small bores are much more affected by a side wind, it was urged that, in the field of battle, lateral deviation is usually of far less moment than correct range and flatness of trajectory; the conditions are very different from those of match-shooting. Besides, the soldier can only carry a certain weight; and long-range fire, breechloading, and magazine arms all point to increased expenditure of ammuition; therefore, the soldier must carry more rounds, and the individual cartridges should weigh less.

Assuming that we have a weapon which will hold five or more cartridges in the magazine, that the latter can be easily reloaded, and also that the rifle may be used as a single-loader, how should it be employed?

On the offensive, fire should be by volleys alone, the final rush should be prepared by the use of the magazine, which should be reloaded the moment the

position is carried. On the defensive, the same principle should be followed, but the magazine may possibly be earlier and more often employed; *i.e.*, at long ranges when it can be rapidly loaded, and at advancing troops during their rushes, when they are more fully visible. In either case, the magazine should be chiefly for close combat, and for the decisive stage when its proper employment may decide the issue.

The introduction of repeaters will, to a certain extent, increase the expenditure of ammunition; but, as a practical fact, this increased expenditure will not so much be a necessity of magazine rifles—properly used—as it will be due to the growing tendency, previously pointed out by him in this Institution, of utilising long-range firearms. Having rifles of accuracy at long ranges, it seems indeed foolish to restrict their use to short distances. But the possession of such weapons demands careful training, both of officers and men.

In the discussion which followed, several gentlemen took part. Colonel Arbuthnot, superintendent Royal Small Arms Factory, agreed with the lecturer that the tendency was in the direction of small-bore rifles, but there were other considerations to be taken into account besides flatness of trajectory; the diagrams exhibited were a little misleading in this respect, as the apparent ground line was really the line of sight.

For military purposes, the barrels must be strong enough to stand rough usage, and there was evidently a limit to reducing the bore by increasing the thickness of metal, and consequently adding to the weight of the arm; also the size of the bullet must be considered. He did not think that the introduction of magazine arms would lead to a lavish expenditure of ammunition, but rather that there would be a tendency to husband it. It was to be trusted that the practical trial of the two selected rifles would eventually result in our being possessed of the best repeating rifle in Europe.

We hope shortly to place before our readers more detailed information respecting the principal magazine rifles referred to in this lecture. It may, in the mean time, be noticed, with reference to the number of shots given as fired from a Soper rifle in a minute, that a recent number of the *Avenir Militaire* gives twenty-seven well-directed rounds as having been fired from a French Gras rifle in the same time. We do not think any military single-loader in Europe attains the rate of fire mentioned for the Soper by Captain James—more especially if manipulated by the ordinary infantry soldier.

THE SOCIETY OF TELEGRAPH ENGINEERS.

IN the discussion which followed the reading of Professor Thompson's paper on "Telephonic Investigations," Mr. W. H. Preece, F.R.S., spoke at considerable length on the question of induction in telephone lines and its influence on the success of long-distance telephony. It will be remembered that Professor Thompson's expressed aim in some of his researches was to devise a telephone which would give effects powerful enough to render it independent of the induction noises in the line. His argument was that a powerful transmitter would enable a less sensitive receiver to be used, a receiver in fact so insensitive to the induction currents that it would remain silent to them, while it would respond to the currents of the transmitter. Mr. Preece contested this idea, and argued that what is really required is a special telephone line, constructed with a view to long-distance telephony, and the exclusion of induction. Mr. Preece admitted that if a large reduction in sensitiveness could be obtained there might be a good deal in Professor Thompson's idea, but hicherto only small improvements in this direction have been possible. He mentioned that the speed of postal telegraph working to Ireland had lately been increased from 170 to 420 words per minute by the substitution of copper for iron wire in the land lines. This speed of working corresponds to 380 distinct currents per second, a figure which approaches the requirements of telephonic speaking. The dominant note of most speakers is the middle C, or 256 vibrations per second. Sibillant sounds, however, reach a rate of several thousand vibrations per second, and Mr. Preece adopted the average of 1500 vibrations per second for telephony. The instance given shows that the nature of the line has an important bearing on the speed of transmission. The law of Thomson and the recent experiments of Professor Hughes bear this out; and there is no doubt that self-induction, as well as mutual induction, has to be attended to in long-distance telephony. Nevertheless, if the nature of the line is one element in the problem, the nature of the instruments is another. There is truth on both sides, and it is by improving both line and instruments that progress will be made. Professor Hughes drew attention to the fact that too little care had been paid to the adaptation of the induction coil to the necessities of the line and the resistance of the battery and transmitter. Recent improvements in the construction of induction coils ought to be useful in telephony, as well as in electric lighting, and the "transformer" may be expected to serve in long-distance working.

Professor Hughes then reverted to the microphone, and expressed his dissent from Professor Thompson's theory of the action of the "valve transmitter." In that instrument a ball of metal or carbon rests on three contact points at the end of a curved speaking tube. Professor Thompson explains that the sound waves passing up the tube impinge on the ball as on a valve in the tube, and cause it to act as a microphone. Professor Hughes, however, is of opinion that the vibrations of the voice really reach the ball through the walls of the tube, and the contact points which project from them. Solid wood, he pointed out, is a much better conductor of sound than air, and if the tube were stopped up below the ball so that the air waves did not reach the ball at all, the sonorous vibrations would still be communicated to it through the tube walls. In fact, until Professor Thompson's contacts and ball are entirely isolated from the walls of the speaking tube, so that the sonorous vibration can only reach them through the air itself, it cannot be said, without any doubt, that the valve telephone operates as its inventor says it does. Evidently the tube acts as a solid vibrator, if not as a diaphragm; but according to Sir William Thomson, the two things are synonymous for the purposes of telephony. This, however, is a vexed question into which we have no desire to enter.

Professor Hughes related an interesting experiment he had made by submerging a microphone in a public bath. The bath, which to the unassisted ear seemed to be still, revealed through the microphone a great confusion of sounds, doors shutting, footsteps, voices, water flowing, all mingled together. The experiment showed the vibratory power of water, and Professor Hughes suggested that Professor Thompson should submerge his 108-microphone transmitter under water instead of actuating it by a solid diaphragm. The microphones might be arranged round the walls of a hollow box and water poured into it until they were covered. On speaking to the surface of the water the microphone would be actuated.

Professor Hughes also mentioned that the microphone is now part of the regular equipment of officers of certain water companies in Germany, where it is used to detect leakage from the pipes by the noise of the water-flow.

Mr. Augustus Stroh and several other speakers then addressed the meeting, and Professor Thompson replied.

Mr. Stroh gave an account of an exceedingly interesting experiment he had made with a microphone under a microscope. He noticed that the carbon points first burn away until a sufficient area of contact is obtained. The microphone is then reduced to silence and is in its best condition for working. Too much or too little area of contact are both undesirable.

Professor Thompson, in conclusion, defended himself against the attacks of Mr. Preece, and carried the war into the enemy's country; the passage at arms between them forming an episode which enlivened the meeting.

NOTES.

A USE FOR THE RADIOMETER.

M. FRÈRE, manager of the St. Quentin Gas Works in France, has for some time past used the radiometer of Crookes to tell the time for putting on "night pressure." It is well known that the vanes inside the radiometer will turn as long as there is a sufficiently intense light falling on them. By taking note each day the time at which the radiometer exposed to daylight ceases to turn, the average time of lighting up or putting on night pressure can be determined for each month. M. Frère is of opinion that without expecting absolutely reliable results, these averages may be useful to gas managers.

THE AIR BRUSH.

The Sub-Committee on Science and Arts of the Franklin Institute have reported on the air brush of the Air Brush Manufacturing Company of Rockford, Illinois, U.S., that it is an acquisition of rare value in the hands of an accomplished draughtsman. The air brush is a tool for applying liquid pigments on paper or other surfaces in the production of pictures. It operates in the following manner: The artist supplies liquid colour from a brush to a spoon-like receiver. Through this liquid a fine needle darts rapidly back and forth, its wetted point being carried beyond the edge of the spoon. A strong current of air blown against the point of the needle blows the colour in fine spray against the paper. When the point is held near the paper a fine line of colour is drawn, and this is widened by drawing the point further off. The greater or less length of stroke of the needle, as well as the current of compressed air playing on it, are under the control of the artist's thumb and foot. The latter is used to work the bellows supplying the air. The Sub-Committee regard the invention as an important aid to the artist, and worthy of the highest award the Franklin Institute can bestow.

A NEW COSMICAL ROCK.

On June 16, 1794, a meteoritic stone fell at San Giovani d'Asso, near Siene, in Italy, and since then it has been found that the stone is a breccia, that is to say, it consists of rocky fragments cemented together by a kind of paste. The fundamental part of the stone is a bluish grey limirickite, and the paste appears to be a grey luceite. According to M. Stanislaus Meunier, a well-known authority on such matters, mesminite is the name given to this order of meteorite or cosmic stone. He has examined the "giovanite" above mentioned by chemical tests and by the microscope, and finds that it tends to confirm the new notion of the community of origin for divers types of meteoric stones, and the exercise of geological actions, properly so called, in that common medium from which they are derived. The older idea that meteoric stones are assimilated to comets, is defective in his opinion. As to the principal argument on which it is based, namely, the occlusion of cometary gases in the stones, he is of opinion that it does not carry the weight attached to it, and that it testifies only to a unity of chemical composition in the different parts of the solar system. While upon the subject, we may mention that an analysis has recently been made of a mass of meteoric iron found in Augusta County, Virginia, U.S. It appears to have been part of a large meteorite which exploded into fragments, of which four have been discovered. It contains ferrous chloride which in diliquescing causes the mass to foliate and crack off. The analysis conducted by Professor J. W. Mallet gives the following composition for the mass: Iron, 90.293 per cent.; nickel, 8.848; cobalt, 0.486; copper, 0.016; tin, .005; manganese, a trace; chromium, a trace; phosphorus, 0.243; sulphur, .012; chlorine, a trace; carbon, 0.177; silica, .092 per cent.

THE LAGGING INDIAN RAILWAY POLICY.

The inquiries that have been addressed to the Government during the past week in regard to the construction of railways in India, have elicited replies of the most unsatisfactory character from the officials concerned. Having, after interminable delays, settled the Bengal Nagpur line, the Government do not intend for the present to encourage any more applications to construct railways under a guarantee. In all, the Government hope to see 1167 additional miles of railway opened for traffic by the end of this year; and, satisfied with this, intend to do no more unless stimulated by public opinion. But however content the India Office may be with jogging along at this pace, its decision will not be viewed with pleasure by those who are conscious how necessary it is to stimulate trade in India and at home by the rapid construction of railways. If the railway extension of India is so advantageous to the finance and trade of the country, as has been demonstrated *ad nauseum* by experts and admitted ungrudgingly by Secretaries of State, why should a limit be drawn at 800 or 1000 miles of railway construction per annum? why not, in these depressed times raise it to four or five times that length? Only a few weeks ago, Viscount

Cross, Secretary of State for India, said that "the average return for Indian railways was 5*l.* 12s. 6d. per cent., and he hoped that the Chambers of Commerce would use their influence in support of calls for English capital for developing them." This fervour appears to have now vanished, for last week, Sir J. Gorst, in reply to Mr. B. Samuelson, said that "it is not intended at present to construct additional railways under a Government guarantee, but all the proposals to dispense with a guarantee would be received favourably." But if Indian railways pay on an average 5*l.* 12s. 6d. per cent., why should there be any hesitation about giving a guarantee of 4*l.* per cent.? So long as guarantees are given at all, capitalists will always hold on in the hope of securing the next of the series, rather than take the whole risk themselves. The present half-and-half policy paralyses everything. In the mean time, there are whole tracts of India, populous and full of resources, upon which, although larger than the whole of England, not a single railway is to be found. Nor will there be, notwithstanding the marvellous development of Indian trade through the building of railways, unless pressure be applied by manufacturers, capitalists, and others concerned. It rests with them to educate the public into infusing life and energy into the Government of India.

ELEVATORS IN RUSSIA.

For the last three years the Russian corn trade has suffered severely from the competition of America and India, and the effect on the revenue has been annually noticed in the budget of the Minister of Finance. Forced at length to do something to cheapen transport, which lies at the bottom of Russia's inability to compete with America, the towns of Riga and Revel have decided to erect elevators, and their example is expected to be also followed by Nicolaeff and Odessa. It is now nearly six years since the Russian Government turned its attention to the matter, and 1882 almost completed a contract with a powerful Franco-American syndicate, giving the latter a monopoly at the principal Russian ports. The scheme, however, was subjected to a prolonged and venomous attack by Katkoff, the editor of the *Moscow Gazette*, whose hatred of the Minister of Finance was notorious, and in the end the minister had to yield to the clamour, and refuse the concession. After this no further enterprise from abroad was forthcoming, and there being none at home, the matter dropped until the present year, when the ruinous condition of the trade compelled the outports of Russia to bestir themselves. Their decision to build the elevators themselves has been well received by the Russian press, and the railways are also going to co-operate in the movement inland. It is quite time that the latter aroused themselves, as their heavy rates and general indifference to goods traffic have contributed not a little to the depressed condition of Russian trade. As an illustration of their charges, the *Novoe Vremya* points out this week that, "although in 1881 a railway wagon full of rye, valued at 571 roubles, or 57*l.*, cost 179 roubles, or 17*l.* 18s. to convey from Saratoff to St. Petersburg, the same quantity, worth last year only 264 roubles, or 26*l.* 8s., cost 195 roubles, or 19*l.* 10s. to be carried the same distance; thus the transport, which in 1881 bore a proportion of only 32 per cent. of the value, bore last year the proportion of 74 per cent." In consequence of the agitation aroused by such statements, it is reported at St. Petersburg that the Czar contemplates transferring the control of the railway tariff from the Ministry of Railways to the Ministry of Finance. Tariff reforms, as well as the introduction of elevators, however, take time to bring about, and in the meanwhile it is to be hoped that India and the British colonies will go ahead and get a still firmer hold of the European market before transport becomes cheap in Russia.

THE "REINA REGENTE."

UNDER the name of the Reina Regente, Messrs. James and George Thomson, Clydebank, have just launched an armoured cruiser which they have built to the order of the Spanish Government. It may be remembered that about eighteen months ago a number of the leading shipbuilding firms of this and other countries were asked by the Spanish Government to submit competitive designs for a warship which should fulfil certain conditions. She was to have an armoured or protective deck 3½ in. in thickness; to have four 20-centimetre 12-ton guns, six 12-centimetre guns, and a numerous small armament; and to be able to maintain a speed of 19 knots per hour, and to have a radius of action of 5500 knots. Messrs. Thomson furnished one of the competitive designs, which was in course of time accepted, and they were intrusted with the order to carry it into execution. In the vessel which they have just launched they have considerably exceeded the conditions originally laid down, as they have given her a protective deck which is 4¾ in. in thickness, and the armament is to consist of four 24-centimetre Hontorio 21-ton guns, six 12-centimetre Hontorio guns, six 6-pounder guns of the Nordenfelt type, two 37-millimetre Hotchkiss revolving guns, and a dozen other small guns and five torpedo tubes. The builders have also provided for a speed of 20½ knots and for a radius of action of 12,000 knots.

Measuring 330 ft. in length, and built entirely of steel, the Reina Regente will have a displacement of about 5000 tons for ordinary sea-going purposes, but when fully equipped her displacement will amount to 5600 tons. In addition to the protection provided by the armoured deck, she has an excellent means of defence in her extensive and very minute internal subdivision, there being no fewer than 156 water-tight compartments. Of these, sixty are beneath the armoured deck, and there are eighty-three between that deck and the one above it, that is to say, in that part of the ship which is situated "between wind and water." Most of those eighty-three water-tight compartments are to be used as coal bunkers, so that any shell or shot that may strike the ship along that belt of her exterior is not likely to get beyond the particular bunker which it may possibly penetrate, consequently it will take many shots to disable the ship.

The Reina Regente is a twin-screw ship, and she is to be driven by means of two sets of horizontal engines of the triple-expansion type, of an aggregate of about 12,000 indicated horse-power. These engines are to occupy separate water-tight compartments. Steam will be supplied to them by means of four large boilers, which will also occupy separate water-tight compartments. In addition to those boilers there will be two of Messrs. Merryweather and Co.'s boilers intended for raising steam rapidly in cases of emergency. They will be placed at some distance above the water-line, and they will have connection with all the auxiliary engines of the ship. Besides the two sets of main engines for propelling the vessel, there will be between forty and fifty other engines, including two starting engines, others for working four 14-in. centrifugal pumps (by Messrs. Drysdale and Co., of the Bon-Accord Engine Works, Glasgow), bilge and fire and feed pumps, ten fan-draught engines, two electric light engines, a capstan engine by Harfield, steering engine and boat-hoisting and ash-hoisting engines by Messrs. Muir and Caldwell, Glasgow.

The pumping arrangements of this highly complicated modern warship are on a very complete scale. All the 14-in. centrifugal pumps are connected to a main pipe which runs from stem to stern of the ship, and into which there are branches from every compartment, these being so arranged that the compartments are always in immediate connection with the pumps, so that if any of the compartments should become flooded they are immediately pumped out, while if the water attempts, in the shape of a return current, to enter a compartment from its respective pipe, it is at once prevented by means of an automatic valve. By these arrangements it is only necessary for the engineer to keep his pumps in action, and any water which may happen to get into any compartment, will be pumped out without the slightest attention. Before leaving the pumping arrangements we ought to mention that the vessel has a double bottom which extends from side to side and throughout her whole length.

Not only is the Reina Regente to have great speed, but she is also to have great rapidity of turning, a point to which much attention has been given in designing this new cruiser, in which there has been fitted a sternway manœuvring rudder designed and patented by Messrs. Thomson and Biles. This type of rudder has given most extraordinary results in the manœuvring of the Russian torpedo boat Wyborg and the Spanish torpedo cruiser El Destructor, both of which were built and equipped at Clydebank last year. With the improvements that have since been made in this rudder, it is confidently believed that the Reina Regente will give even still better results.

In this new cruiser the quarters of the officers and the crew will occupy the whole of the main deck—the accommodation to be provided being for 50 of the former and 350 of the latter. Right forward on this deck there are two torpedo tubes; there is also one right aft, and one in each broadside amidships. On the level of the main deck, but projecting beyond the side of the ship, there are four gun towers. The two forward ones fire each 5 deg. across the bow, and to within 30 deg. of right aft; while the after ones have a similar range round the stern. The remainder of the armament is placed on the upper deck, at the fore end of which there is a platform raised about 4 ft. above the deck, and upon this two of the 21-ton guns will be placed. These guns will fire right ahead, and to within 40 deg. of right aft. The supports of these enormous guns extend right down to the bottom of the vessel, and the ammunition is supplied to them through two heavily armoured hoists. The other two 21-ton guns are placed on a similar raised platform aft, and between the two platforms and ranging along both sides of the ship, there are placed the six 12-centimetre guns, two of which fire right forward, two right aft, and the other two having a range of 140 deg. It is stated that the 21-ton guns could with great ease pierce the armour of any of the armour-clads afloat or building, and that the other six guns referred to will be able to pierce the armour of any of the belted cruisers now building for the British Navy. Five of the small guns included in the armament of this cruiser, are intended for boat and field service, and other four will be worked from the mast-heads. In all there will be thirty guns in the armament of the Reina Regente, which, considering the tonnage of the vessel, must be regarded as very formidable.

At the launch of the Reina Regente, the Queen Regent of Spain was represented by the Duke and Duchess of Wellington, the latter of whom performed the christening ceremony. There were also present many other distinguished persons, including the Spanish ambassador and various members of the Royal Spanish Naval Commission in London.

TECHNICAL EDUCATION.

TO THE EDITOR OF ENGINEERING.

SIR,—I am directed to request that you will be so good as to allow me, through the medium of your columns, to inform manufacturers and others engaged in industries in which art is more or less concerned, that the Lords of the Committee of Council on Education have decided to make arrangements for the admission of a limited number of persons employed in those industries, to study in the South Kensington Museum, Library, and Schools, without the payment of any fees, for periods of from two to nine months according to circumstances.

Detailed rules with regard to these working studentships will be sent on application to the department. Briefly, the conditions may be stated to be, that the designer or workman, for whom admission is sought, shall show that he has sufficient power of drawing and sketching to be able to profit by the opportunities afforded; that he is actually engaged in some art industry, and that the proprietors of the works in which he is engaged undertake to maintain him while he is studying at South Kensington. When admitted, the working student will be set, under direction, to study in the Museum and Art Library from examples relating to the industry in which he is employed, and he will also receive instruction in drawing and designing in the Art School, suited, as far as may be, to his special case.

My Lords have taken this step with a view to render the museum of more special and direct use to the country, and they trust that the valuable collection of examples of applied art which has now been brought together, may thus be more fully appreciated and taken advantage of by the directors of industry in the country.

I am, Sir, your obedient servant,

J. F. D. DONNELLY.

Science and Art Department, February 28, 1887.

MEASURING THE DEVELOPMENT OF GREAT POWERS.

TO THE EDITOR OF ENGINEERING.

SIR,—In reply to your correspondent M., I beg to say that the brake used by Professor Thurston was described in the Journal of the Franklin Institute for April, 1886. Another, but much smaller, Halpin brake was described and illustrated in ENGINEERING for April 21, 1882. I may add that I have myself used this form of brake for several engine tests, and with the greatest satisfaction. At one test it was taking off about 40 horse-power continuously for seven hours, and not the slightest adjustment of any kind was required during this time, the only attention it received being a few drops of oil now and then, and I believe it could have been kept running for an indefinite time. Diameter of wheel was 7 ft., and revolutions 139 per minute. The "Amos" compensating levers were used as illustrated for brake on April 21, 1882.

Yours truly,

W. SCHÖNHEYDER.

81, St. Stephen's Avenue, Shepherd's Bush,
London, W., Feb. 26, 1887.

THE INTERCHANGEABLE AUTOMATIC BRAKE.

TO THE EDITOR OF ENGINEERING.

SIR,—As I notice in your editorial note to Mr. Stokes's letter, page 165, you say some of your readers may like to make a few remarks, I beg to trouble you with the following:

I was under the impression that the new "interchangeable" brake was to be made to work with the other two, but now Mr. Stokes says it is to *supersede* both the others; then under those altered circumstances I should think it ought to be named the "supersedeary brake." The train at the trial, we are now told, was not perfect in all minor details; why, I ask, was it not? Surely the inventors could fix their own time for the trial, why then did they bring out a train half fitted? It is, I fear, the old excuse to cover a fault, "the details were not quite complete."

Mr. Stokes says: "When once the Westinghouse brake has been applied and the vehicle has been disconnected from the engine, the brake is completely '*dead*.'" Now this is all nonsense. When the Westinghouse is applied

and the engine disconnected, the brake on the vehicle in question is "*hard on.*" I don't call that dead, I call that wide awake, and doing its duty; and what more can be wanted?

Further on Mr. Stokes says a triple valve is "complicated"; that is not true. Where can you find another bit of machinery doing the work the triple valve does with so little trouble?

Now I may make a few remarks on the new brake:

1. At speeds of over 25 miles an hour it is short of brake power, as shown by the length of distance run at high speeds.

2. When stopping, the piston and dead weights were jerked up and down, so that the brake was taken partly off, and did not hold properly.

3. This interchangeable brake is not full on till *all* the air is let out of the pipe. Now the Westinghouse is on with a 20 per cent. reduction of pressure. This interchangeable system must be slower in action, and waste a great quantity of air, both in putting on and taking off.

4. Lastly, as to leakage. Your readers all know that the Steel-McInnes brake was no good, because they could not pack a piston-rod without too much leakage. Now in this *new* system here we have an 8 in. piston under full air pressure under each vehicle all the time the brake is off. Only think of the waste of air. Steel could not make tight piston-rods. Is, then, Parker-Smith or any other man going to make 8 in. or 10 in. pistons air-tight?

Turning now to the vacuum brake when working with the "interchangeable"—the interchangeable being in action first, would not work well with the vacuum brake proper, and there would be jerks and broken couplings and drawbars. The leakage would be so great that no two vacuum ejectors at present on any locomotive would be able to maintain a vacuum and keep the brakes "off." There is one remark in Mr. Stokes's letter that I do agree with, where he says "the safety of the travelling public demands the use of the best possible brake." Yes, certainly, and the best possible brake is the Westinghouse automatic; but I hardly need to tell you that, as your readers must well know this by experience and results of trials.

Your obedient servant,
February 19, 1887. RAILWAY MAN.

TO THE EDITOR OF ENGINEERING.

SIR,—As you invite correspondence on the subject of automatic brakes, permit me to make a few remarks in reference to Mr. Stokes's letter appearing in your last issue, in which he seems to display a one-sided view of the question, and unreservedly plants his standard with the "Welch-Parker-Smith automatic interchangeable brake system."

Mr. Stokes tells us that the new brake is intended to eventually supersede all others in the market. Now, Sir (although I admire that gentleman's candour and confidence over the concern, and trust his expectations may soon be realised), surely it is a little premature and too-pronounced a view to take up, based as it is upon statistics of only a preliminary and experimental character. Of course time alone can positively prove whether such an assertion will be verified, but until further experiments are carried out under ordinary working conditions, with a train of not less than five-and-thirty wagons, it is impossible for engineers to accept the brake as one far in advance of both the Westinghouse and vacuum system, or even equal to them.

As the result of my small experience with long-linked toggle-joints employed for brake purposes, I must indorse all you have stated in a late issue on the disadvantages of such an arrangement, and I do not think the automatic "take-up gear" provided in the new brake sufficiently obviates, or meets the objections.

Engineers will look forward to seeing how one of the principal features and advantages claimed for this automatic interchangeable brake answers in practice, namely, the facility offered for easing off and on the brake power by augmenting or reducing the pressure or vacuum, as the case may be, in the through connections, and it is a pity time did not permit experiments on those points to be carried out.

In conclusion, I should like to add, that even assuming the principle of the new brake to be correct, many defects in mechanical detail remain to be eliminated before actual and definite practical success can be achieved. In the mean time further and more exhaustive experiments will be anxiously looked for by all those interested in the subject, and amongst whom may be numbered,

Yours faithfully,
F. SANDERS MORRIS.

Chandos Chambers, 22, Buckingham-street,
Adelphi, W.C., February 21, 1887.

TO THE EDITOR OF ENGINEERING.

SIR,—I am glad that you are affording an opportunity of a further discussion on the brake question opened by Mr. W. Stokes's letters in your last number. As one who has long been an advocate for automatic brakes, and who has had considerable experience in their working, will you allow me to say a few words. I am convinced that either the Westinghouse or the automatic vacuum brakes if properly looked after are quite capable of satisfying practical requirements, and my own preference is for the automatic vacuum as the simpler of the two. But I do not think either would work satisfactorily in conjunction with Mr. Stokes's brake. I will let those who have had more experience than I have speak as to the probable results when working the new brake in conjunction with Westinghouse apparatus, but I may be permitted to say that I think it would "kill" the automatic vacuum if worked in connection with it. The essence of the automatic vacuum is the ease with which all joints can be kept tight, and the consequently very small amount of work to be done in maintaining a vacuum. The smallness of the steam jet constantly used shows this, and it is impossible to imagine a more simple contrivance. But with Mr. Stokes's big stuffing-boxes the circumstances would be vastly different. What I would suggest is that Mr. Stokes or his friends should rig up say twenty or twenty-five of the interchangeable brake cylinders with pipes, couplings, &c., in a yard at any convenient factory where steam power is available, and apply the brakes say every five minutes for days (not attending to the packing), and then see how an ordinary automatic vacuum brake small ejector will maintain the vacuum. This is a trial which can be readily made without troubling any railway company.

I am yours truly,
Sheffield, February 21, 1887. MIDLAND.

FIREBRICKS.

TO THE EDITOR OF ENGINEERING.

SIR,—You or any of your readers will much oblige me with the information which are the best sort of firebricks and cement that are used in furnaces with artificial blast or draught, for extracting lead from the refuse of lead works, and which will withstand the freed gases from the lead the longest? With thanks for the answer,

Yours truly,
Rotterdam, February 26, 1887. W.

EXTRACTING CASTOR OIL BY SCREWED PRESSES.

TO THE EDITOR OF ENGINEERING.

SIR,—Can any of your readers inform us of the general construction of these presses as used in India, and which we believe are worked by a spur pinion gearing into a spur wheel keyed on to a lay shaft, at the other end of which would be a bevelled pinion gearing into a bevelled wheel, the latter forming a nut for the press screw to work into? We only surmise this arrangement from the scant information we have to hand, and would be glad to be put right, and to know if such presses are worked by power or by hand. Also how many cakes are made at one pressing and the usual size of the cakes? What sort of wrappers or envelopes are used for wrapping the castor beans in, and what sort of press boxes? Are the kernels of the beans ground into meal before pressing, and are they pressed hot or cold, also are two separate pressings required? Our Indian friends require such a press to crush about 1000 lb. of castor beans in 11 hours. They are at present trying to crush the castor meal in a small Anglo-American hydraulic press, wrapping the hot meal in woollen wrappers and placing it between the open press plates. They do not find this satisfactory, owing to the continual bursting of the woollen wrappers. The most important question to us is how to envelop the meal, and what sort of press boxes to use, so as to contain the meal without squirting out when under pressure and without bursting the envelopes. Any information will be greatly esteemed by

T. AND W. SUMMERS,
Engineers, Gloucester.

DREDGING.

AT the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, the 1st of March, Mr. Edward Woods, President, in the chair, the paper read was "Dredging Operations and Appliances," by Mr. John James Webster, M. Inst. C.E.

The author commenced by stating that in all projected schemes for either the construction of harbours, docks, and canals, or for river improvements, one of the most important questions to be taken into consideration was that of the dredging operations, and the form of appliances best suited for the existing conditions and requirements. Dredging operations were generally carried out for the following objects: (1) To prepare the surface of the ground under water for receiving the foundations of some structure such as a breakwater, pier, quay wall, or bridge piers; (2) for deepening or widening an existing canal or river; (3) for cutting a new river course, canal, or channel, or diversions of existing ones; (4) for removing obstructions to navigation, such as a bank or bar at the mouth of a river, harbour, or dock; (5) for removing the deposits which accumulated from different causes after any of the above works had been executed. He then spoke of the advantage of obtaining the aid of natural scour, when possible, for supplementing or dispensing with dredging. As instances he mentioned, on the one hand, the improvements at the mouth of the Mississippi, which had been obtained by training works and resulting natural scour; and, on the other hand, the Suez Canal, which had been accomplished entirely by dredging. As notable examples of the two operations combined, he referred to the cases of the Clyde and of the Tyne. The depth at high water in Glasgow harbour had been increased from 5 ft. 8 in. to 26 ft., and at low water from 18 in. to 15 ft. The improvement had been almost entirely due to the later dredging operations, over 60,000,000 cubic yards of material having been removed within the last forty years, and about 1,500,000 cubic yards were still dredged annually to maintain the channel. The works on the Tyne had improved the river for a distance of 19¼ miles from the bar, where the depth at low water had been increased from 6 ft. to 20 ft. or 24 ft. by the combined action of training-walls, breakwaters, piers, the removal of obstructive rocks, and by dredging operations, 46,000,000 cubic yards having been excavated since 1862. Referring to the great cost of removing silt from docks, the plan successfully adopted by Mr. Abernethy, Past-President Inst. C.E., at the new Alexandra Dock at Hull, was mentioned, where the influx of the muddy river water was prevented by replenishing the dock by pumping in water from a clear stream.

The author next alluded to the expensive operation of the disposal of the dredgings, and of the vexed question of the propriety of discharging them in the tideway of an estuary. The earliest dredging operations had been apparently carried out by the Italians and by the Dutch, the latter being credited with the introduction of the "bag-and-spoon" dredger. The first steam dredger was fitted with an engine by Messrs. Boulton and Watt in 1796, to work in Sunderland Harbour.

The various appliances adopted since then had been thus classed: (1) Miscellaneous dredging apparatus; (2) sand-pump dredgers; (3) dip or bucket dredgers; (4) bucket-ladder dredgers; (5) hopper dredgers; (6) hopper barges. Under class (1) came Kingsfoot's dredger, used for cleansing the River Stour; Rietschoten's propeller-dredger, used for removing shoals on the River Maas; Lavalley's injection and suction dredger, used in the harbour of Dunkirk and elsewhere; the Aquamotrice, designed by Mr. Popie for use on the Garonne and other rivers; the rake dredger, used by the Danube Steam Navigation Company. Under class (2) were included Woodford's sand-pump, Burt and Freeman's sand-pump, Schmidt's sand-pump, the Bazin sand-pump, and Kennard's sand-pump. Class (3) comprised the native Indian "Jham," Ives's excavator, Milroy's excavator, the Clam-Shell dredger, Bull's dredger, Gatmell's excavator, Four-acres' dredger, Bruce and Batho's dredger, Priestman's bucket dredger, and Duckham's pneumatic dredger. Of most of these machines descriptions were to be found in the Minutes of Proceedings, but were here collected together in a concise form. Many were now illustrated by models, photographs, and drawings.

The bucket-ladder dredgers of class (4) being generally used for heavy and important works, were treated more in detail. After referring to the two earliest machines of this class, used at Hull and Sunderland, the following important points were considered in connection with them: The relative advantages of single and double ladders, the hull, engine and boilers, driving and hoisting gear, top and bottom tumblers, buckets, links, and pins, and the shoots. The question of the power required to work dredgers was next dealt with, and the nature of observations made by the author, and the result of those of other engineers were described. Indicator diagrams had been taken from the engines of a large number of dredgers, under the following conditions: (1) With the engine running alone; (2) with the buckets in gear but not dredging; (3) with the dredger working with full buckets. From these cards it appeared that the percentage of the whole indicated horse-power, required to overcome the friction of the machinery, varied from 44 to 98 per cent. From these cards the author had attempted to frame the following empirical formulas for ascertaining the indicated horse-power required to dredge different materials under varying conditions. If H was the height of the top tumbler from the surface of the ground and W the number of tons to be dredged per hour, then

$$1\,H.P = 0.040\,W\sqrt{H}$$ for very stiff clay or mud;
$$= 0.034\,W\sqrt{H}$$ for hard clay and indurated mud; and
$$= 0.026\,W\sqrt{H}$$ for soft mud and light sand.

Referring to the cost of dredging, the author remarked upon the difficulty of obtaining reliable information as to the actual cost, including everything, advocates of special machinery, and engineers for other reasons, putting the cost at a minimum, and possibly leaving out some important item. The cost of dredging was given for a number of places where extensive operations had been carried out. The author then described the different kinds of hopper-dredgers, including those made by Messrs. W. Simons and Co.; Messrs. Fleming and Ferguson; the hydraulic hopper-dredger, by Messrs. Bruce and Batho; and the hopper-barge, at Liverpool, fitted with four of Priestman's buckets.

THE INSTITUTION OF CIVIL ENGINEERS.—At the ordinary meeting on Tuesday, March 1, Mr. Edward Woods, President, in the chair, it was announced that the Council had recently transferred William Berrell, William Gilchrist Gilchrist, Andrew Jamieson, F.R.S.E., Charles Coxhead Lindsay, Joseph Parry, and William Henry Warren, Wh. Sc., to the class of members; and had admitted the following candidates as students of the Institution: George Thomas, Cooke Adams, John Reid Anderson, Sidney James Bird, George Thomas Burdett, Robert Hearn Charters, Richard Haworth Clayton, Frederic Brereton Dixon, Harry John Fereday, Ernest Nevill Giles, John Maxwell Sullivan Green, James Albert Grayson Harrisson, William Jones, Francis Maddison Long, Arthur Charles McMinn, Jun., Humphrey Alexander Minchin, William Vane Morris, Julian James King Salter, Harry Shoosmith, Wh. Sc., Harold Duke Smith, Ronald Caemmerer Sutherland, Guy Laurence Till, Walter Robert Underhill, Herbert William Lewis Way, William Fischer Wilkinson, and Penrose Lanyon Watkin Williams. The monthly ballot resulted in the election of four members, viz.: Alfred Brydges Giles, George Clementson Greenwell, Jun., Thomas Urquhart, and William Ward-Smith; of twenty-five associate members, viz.: James Adam, F.C.H., Stud. Inst. C.E., Percy Munro Beaumont, Stud. Inst. C.E., John Alexander Craig Blue, Edward Johnson Brown, Frank Bullock, Edmund Charrington, Stud. Inst. C.E., Alexander Graham Drury, Stud. Inst. C.E., Frederick Robert Foot, Robert Abbott Hadfield, Anthony Grant Hobson, Stud. Inst. C.E., Francis Lindsay Keir, John Kyle, Jun., Stud. Inst. C.E., George Anthony Lefroy, Frederick Fraser Miller, Stud. Inst. C.E., Cuninghame Wilson Moore, Henry Charles Mylne, Florence O'Driscoll, John Parker, John Paton, Stud. Inst. C.E., John Moorhead Power, B.A., Thomas Roberts, James Saxby, Jun., Stud. Inst. C.E., David Simson, Stud. Inst. C.E., George White, and Thomas Charles Hutchinson White.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The shipments of steam coal last week were again upon a large scale, amounting for the seven days to 166,000 tons. Prices have shown a firmer tone all round, one good contract having been taken for immediate delivery at 8s. 9d. per ton. Small steam coal, notwithstanding an increased output, has risen to 4s. 6d. per ton, while for the best descriptions 4s. 9d. per ton has even been obtained. A good demand has prevailed for small coal, although the patent fuel trade has shown no improvement. The exports of iron and steel have been fairly good, and most of the works are well employed. Pig has been a little firmer, but although steel rails have been in fair demand prices have not improved.

Wages in South Wales.—A meeting of the joint Committee of the Monmouthshire and South Wales Collieries Association was held at Cardiff on Saturday, Mr. E. Jones presiding. It was decided to reduce wages to the extent of 2½ per cent. as from March 1, 1887.

Pontypridd.—On Thursday the Albion Steam Coal Company intersected the celebrated Aberdare Upper Four-feet seam at its pits near Pontypridd. The seam was found at a depth of 26 yards below the Two-feet Mine seam sunk through about a month since. The Two-feet Mine seam proves to be 6 ft. 8½ in. thick, and the Upper Four-feet seam has proved to be 6 ft. 8 in. thick with a rock top.

Gloucester.—On Wednesday an adjourned meeting of the Gloucester Chamber of Commerce was held to discuss the question of local port improvements. At the annual meeting a fortnight since, Mr. Nelson Foster proposed a resolution reaffirming the approval of the Chamber to a project for the improvement of the Worcester and Birmingham Canal, and stating that without pledging the Chamber to any particular scheme, it was of opinion that, with the object of protecting the interests of Gloucester, it was of imperative importance that additional port facilities should be simultaneously provided to accommodate the larger vessels now employed in the ocean-carrying trade. To this Mr. Seekings on Wednesday moved an amendment expressing an opinion that the interests of Gloucester imperatively demanded that additional facilities should be provided for accommodating the larger class of vessels now employed in the ocean-carrying trade. He urged that Gloucester should confine its attention to improving its own communication with the sea, and not assist in the larger scheme of improving the waterway into the Midlands, as the latter would only benefit the lower part of the Bristol Channel and increase their competition with Gloucester. Mr. J. Dixon supported the proposal for a new entrance to the canal from the Severn, at Shepperdine, four miles below Sharpness, and also certain improvements in the Worcester and Birmingham Canal. The President (Mr. Thorpe) supported Mr. Seeking's amendment. Mr. Foster, in reply, urged Gloucester not to refuse the aid offered to it by the Midlands to carry out the great improvements suggested. The amendment was negatived, only two hands being held up for it, and the resolution was adopted unanimously. Another resolution, moved by Mr. A. S. Slater, was also passed, affirming that the interests of Gloucester required that the Town Council should secure some control over any improvements to be made in the water communications above and below Gloucester, and over the tolls to be charged.

Rhondda and Swansea Bay Railway.—The report of the directors states that the receipts during the past six months were prejudicially affected by strikes which occurred in the Avon Valley. In every instance work has now been resumed. In consequence of a misunderstanding with the Great Western Company working arrangements for the interchange of goods and mineral traffic at Cymmer Junction have not yet come into operation. Difficulties experienced in obtaining possession of land required at the Rhondda end of the tunnel have been removed, work at both ends is now being actively pushed forward, and about 1016 yards of heading have been driven.

The Electric Light at Ynyshir.—Some interesting experiments with electricity have been made at the Standard Colliery, Ynyshir, in the presence of a number of colliery managers and officials from various parts of the Rhondda Valleys. The Gülcher Electric Light and Power Company has erected at the Standard Colliery an installation consisting of sixty-five 16 candle-power Swan lamps, thirty-five lamps being used for surface lighting and thirty under ground. In the fan engine house a six horse-power Marshall Class B horizontal high-pressure engine has been placed, fitted with automatic expansion gear, fixed and driven direct from the flywheel on to a No. 2*a* Gülcher compound wound dynamo machine of the latest pattern. The machine is capable of driving 100 Edison-Swan lamps of 16 candle-power. The speed of the dynamo is low. At the bottom of the pit the cable ends in a strong slate terminal box, about 10 in. square, made of 1 in. thick slate, and carrying a positive and negative terminal bar, with four cut-outs and terminals to each. From this point three circuits of ⅞ highly insulated cables are led to the underground lamps.

Submarine Mining.—The first of two twin-screw steamers for submarine mining service building by Messrs. Cox and Co., Falmouth, for the War Department was launched on Thursday. The vessel was named the Sir John Jones. The contractors propose to launch the second vessel on Wednesday.

The Dockyard Service.—Mr. Stainer, formerly chief constructor at Chatham Dockyard, and now civil assistant to the Admiral Superintendent at Portsmouth, is expected to be appointed to the vacant office of assistant director of dockyards at the Admiralty. Mr. B. Barnaby, civil assistant to the Admiral-Superintendent at Chatham, will succeed Mr. Stainer at Portsmouth, and Mr. Deadman, formerly constructor at Chatham, will succeed Mr. Barnaby at Chatham.

A National Institute for Wales.—The Marquis of Bute has given 1000*l.* towards the establishment of a National Institute for Wales at Cardiff, for the advancement of literature, art, and science as a jubilee memorial. The scheme is expected to involve an outlay of 17,000*l.*

Milford Docks.—The half-yearly meeting of the Milford Docks Company was held on Monday at Palmerston-buildings, London, Mr. T. Wood in the chair. The directors' report stated that the progress of the works had been satisfactory, and that there was every reason to believe that the works would be completed in August. The directors added that they had been in communication with the Great Western Railway Company, and that they had received assurances to the effect that all reasonable accommodation required by the trade of the docks would be willingly afforded.

EXHIBITORS' CLUBS AT THE MANCHESTER EXHIBITION.—The deputation appointed at the meeting of exhibitors held at the Victoria Hotel, Manchester, on February 25th, Tuesday last, waited on Sir Joseph Lee, and obtained permission to erect a suitable building for an Exhibitors' Club, to provide special accommodation—reading, writing, smoking, and refreshment rooms, telephone accommodation, &c., in the Exhibition grounds. Another meeting of the exhibitors is to be held at the Victoria Hotel, Manchester, on Tuesday next, the 8th inst. All desirous of joining the club are requested to communicate with Mr. Fletcher Tonge, Pendleton, Manchester.

CANADIAN PACIFIC RAILWAY.—Extensions of the Ontario and Quebec system to Montreal on the east, and London on the west, will be opened in the spring. The extensions are being built in a substantial manner. Engineers are laying out an extension from London to the Detroit, and building operations will be commenced before long. The Saulte Ste. Marie line from Algoma Mills will be built by August. Some of the contracts have already been let. A short line to the lower provinces is being rapidly built, and will shortly be completed to the Maine boundary. No serious climatic difficulties have been experienced at present in working Canadian Pacific trains over the Rockies.

LONDON SANITARY PROTECTION ASSOCIATION.—The sixth annual general meeting of this Association was held on Saturday at 1, Adam-street, Adelphi, Lord Chelmsford in the chair. It appeared from the report that the Association is in a fairly prosperous condition, the number of members being slightly increased, and standing at present at 1144. On the motion of the chairman, seconded by Mr. E. C. Robins, F.R.I.B.A., the report and accounts were adopted, the chairman referring in his remarks to the proposed legislation on the subject, and to the great benefits which had followed the inspection by the Association of the Victoria Patriotic Asylum. The Duke of Argyll was re-elected President, and the Council were also re-elected with the addition of General McLeod Innes. A vote of thanks to the Council concluded the proceedings.

STAMP BATTERIES FOR THE QUEENSLAND GOLDFIELDS.—The companies who have recently obtained large capital from the British public for the working of the rich goldfields of Queensland, appear now to be turning their active attention to the development of their properties, especially as complaints have been finding expression with reference to the delays in erecting the necessary plant for crushing the quartz and extracting the gold. It is well known, however, that the ores of Queensland require careful treatment, and the question of machinery is a matter not to be lightly dealt with. We have little doubt that those responsible for the future success of the plant and the result of its operations on the gold-bearing quartz have very good reasons far taking time in making their selections. The directors of the No. 2 Queen Gold Mining Company, with numerous other gentlemen interested in the Queensland fields, visited Lincoln on Tuesday and Wednesday last for the purpose of inspecting a twenty-five head quartz mill especially designed and constructed for them by Messrs. Jordan, Son, and Commans, and Robey and Co., which firms have recently amalgamated their business in mining machinery. This battery is mounted on solid steel framing constructed of double rolled joists framed together with heavy gusset plates forming an extremely rigid mounting; the cams are forged out of the best scrap iron steel plates, being welded on the wearing faces, the cam shafts being of steel 5½ in. in diameter. The tappets are constructed of an improved pattern which prevents the possibility of slip on the stems and admits of very simple adjustment, and the shoes and dies are made of a special steel to resist wear. The mortar boxes are designed to carry five heads each with a lift of about 850 lb.; the section of these boxes is something between the Australian and Californian type, and they are specially designed for fine reduction so necessary for the class of ore to be dealt with. The whole mill of twenty-five heads is braced together with steel girders so as to form one complete mill, each five heads, however, having a separate shaft and driving pulley, so that any section may be driven or thrown out of action independently. This improved mill is, we understand, to be shipped immediately, and we shall hope to be able to report soon that some of the other companies are making similar endeavours to produce the results naturally looked forward to by their expectant shareholders. We hope to be able to illustrate the mill referred to above in a subsequent issue.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market was much depressed last Thursday, and prices suffered a decline all round. At the close the price of Scotch iron was, buyers at 44s. 1d. cash and 44s. 4d. one month, with sellers at ½d. per ton higher; so that there was a fall of 2½d. on the day. Business was done in Cleveland warrants at 36s. 1½d. one month and 35s. 9d. cash, and the closing quotations were 3d. per ton under those of the previous day. A fall of 1½d. per ton took place in the price of hematite warrants, the rates in the afternoon being 47s. 7½d. cash and 47s. 9d. one month. On the following day an advance of 2½d. per ton was made in the price of Scotch warrants, but the gain was subsequently lost, the closing quotations in the afternoon being buyers at 44s. 1d. cash and 44s. 4d. one month, and sellers at ½d. per ton higher. Cleveland warrants closed at 35s. 7½d. cash, which was 1½d. down, but still 1½d. per ton over the closing quotations on the previous Friday. A severe depression took place in the price of hematite warrants, the fall being 4½d. per ton, thus showing a loss of 5½d. per ton on the week. In Monday's market Scotch warrants further declined in price, the close being 43s. 7½d. which was, however, 2½d. per ton above the lowest. No business was done in Cleveland iron, but prices declined until 35s. 4½d. buyers, was reached at the close of the market. The prices of hematite warrants were very irregular, and the close was buyers at 46s. 7d. cash, or 2d. above the lowest quotation, and showing a decline on the day of 6½d. per ton. On Tuesday, in view of the less encouraging reports from America and elsewhere, and of the reported increases in stocks all round, there was a smart fall in the price of iron. Scotch warrants declined 4d. per ton; Cleveland, 3½d.; and hematite, 7d. per ton. Over the two days there was a fall in the money value of the public holdings of warrant iron amounting to about 56,000*l.* The market was again depressed to-day. In the forenoon prices declined to the extent of 3d. per ton in the case of Scotch warrants, 7½d. in the case of Cleveland iron, and hematite warrants 6d. per ton. Prices fluctuated somewhat in the afternoon. There is certainly no improvement to record in respect of the iron trade generally, and in most cases the reports coming to hand from the great iron-consuming centres abroad show little or no encouragement. Most of the special brands of Scotch iron are in very limited demand, and the consequence is that the prices of the same have very considerably declined of late. A more abundant supply of coal is now available over the whole of Lanarkshire, but up to the present there is still no announcement of the fourteen blast furnaces that were recently damped down having again got into full operation. The number of furnaces in full blast remains at sixty-one, as compared with ninety-four at this time last year, and ninety-three two years since. But even with the greatly diminished number of furnaces blowing the quantity of iron put into the warrant stores last month was fully twice as great as the addition made during the month of January—the quantities being, respectively, 3950 tons and 1848 tons. Last week's shipments of pig iron from all Scotch ports amounted to 6078 tons, as against 8063 tons in the preceding week, and 7699 tons in the corresponding week of last year. The United States took 1035 tons; India, 100 tons; Australia, &c., 151 tons; Italy, 100 tons; Holland, 975 tons; other countries took smaller quantities, and 2625 tons were sent coastwise. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores yesterday afternoon stood at 846,237 tons, as against 845,219 tons yesterday week, thus showing an increase for the week of 1018 tons.

Termination of the Miners' Strike.—As the result of a conference held last Saturday week, consisting of an equal number of representatives of the coalmasters and miners of the counties of Fife and Clackmannan, the strike which was threatened in those two counties has been averted, the masters having conceded an advance of wages amounting nominally to an increase of 10 per cent. on the rates then current. Acting upon that example, the coalmasters of Lanarkshire last week made an offer to the men out on strike that, if they would at once return to their work, they would bind themselves to hold a conference with an equal number of *bond fide* miners to consider the matter in dispute in respect of wages, the conference to be held after the lapse of ten days. Almost universally the men returned to their work last Friday, their belief being that they had gained a great moral victory, as this is the first occasion on which the coalmasters have consented to meet with their workmen on equal terms in a conference. Truly, the employers of labour are undergoing an education, for they have now learned that when workmen peacefully combine in their masses they can exert a great influence. The conference is to be held in this city next Tuesday.

Resignation of Mr. W. R. Kinipple, C.E.—Mr. Walter R. Kinipple, Mem. Inst. C.E., who has filled the responsible office of consulting and resident engineer of the Greenock Harbour Trust for a period extending over twenty years, has placed his resignation in the hands of the trustees. Mr. Kinipple was appointed to the office which he now resigns when the Garvel Docks were first contemplated. On their completion he now proposes to return to the metropolis.

Lord Blantyre and the Clyde Navigation Trustees.—Lord Kinnear, one of the judges in the Court of Session, disposed of an action-at-law raised by Lord Blantyre against the Clyde Navigation Trustees. The main dispute between the parties was whether the trustees had, by their operations, raised the level of the water of the Clyde to such an extent as to cause destruction to the banks of the river opposite Erskine Ferry, about ten miles below Glasgow. Lord Kinnear held that the pursuer, upon whom the onus of proof lay, had failed to establish his case. The

second point in the action was whether the trustees had by their operations interfered with the pursuer's access to the river; and the result of his lordship's examination of the evidence was that he was perfectly satisfied that the foreshore of Erskine was altered for the worse, but he was not satisfied that that was owing to the trustees' operations. He thought that the more probable cause was the enormous increase of sewage from Glasgow, which was now brought by the river and deposited opposite Lord Blantyre's lands. The third point in the case was as to the condition of the drains, and on this point also his lordship held that the pursuer had not proved his case. As the result, the trustees were assoilized, with expenses. During the past dozen years or so Lord Blantyre has scarcely ever been free from litigation with the Clyde Trustees, and always as the pursuer.

Clyde Shipbuilding Trade—Launches in February.—The new work turned out from the Clyde shipbuilding yards during the past month was the smallest aggregate for the corresponding months over many years. Only nine vessels, of a total of 7245 tons were launched or taken and shipped in pieces, being 4155 tons under the output in the same month last year, and 23,405 tons less than that of the same month in 1883. The leading feature in the month's output was the launch of the Reina Regente, a Spanish warship of 5000 tons normal displacement. There is a considerable improvement as regards the amount of work in hand; indeed, since the beginning of the present year some 33 new keels have been laid, as against 19 vessels that have left the stocks.

The Tay Bridge.—After waiting for several days for good weather, the contractors for the construction of the Tay Bridge accomplished a very important step, which was the floating out of the last of the girders and its subsequent elevation into position. This is one of the 245 ft. spans. It was successfully got into position.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The Hull and Barnsley Railway.—On Saturday last Colonel Smith presided over the half-yearly meeting of the shareholders of the Hull and Barnsley Railway. He said that was the first occasion on which they were able to compare, in any reasonable way, the traffic of the half-year just concluded, with that of the corresponding half of last year. He trusted that the result was one that would encourage them to persevere in their undertaking. The accounts showed a gross revenue of 92,062*l.*, against 54,800*l.*, being an increase on the half-year of 37,262*l.* The working expenses had been 65,583*l.*, as against 48,100*l.* The net result was that they had earned 26,478*l.*, against 6700*l.* in the corresponding period of last year, or an increase of 19,769*l.* The working of the Alexandra Dock showed an increase of the gross traffic of 11,653*l.*, and left them a net profit on the working of the dock of 5740*l.*, as against almost nothing in the corresponding period of last year.

Scarborough and Whitby Railway Company.—At the half-yearly meeting of the Scarborough and Whitby Railway Company, held this week, it was stated that the report was very unsatisfactory. This fact was stated in ENGINEERING last week. The chief cause of the dissatisfaction is the absence of a good through service between Scarborough and Middlesbrough. The action of the chairman of the company was criticised, and Mr. Maxwell Muller moved that he be asked to resign the chairmanship. The resolution was seconded and carried, but several shareholders abstained from voting.

Improvement in the Leeds Engineering Trade.—Messrs. Kitson and Co. have received an order for about thirty locomotives. This will place a number of men, who have been partially employed, in full work.

The Shipping Trade at Hull.—During the past week there was a very fair increase in the tonnage of this port, both in comparison with the preceding week and the corresponding period of last year. Both imports and exports showed a satisfactory improvement. In the inward tonnage, as compared with a year ago, there was an increase of over 8000 tons and about the same improvement in the outward tonnage. The vessels leaving on oversea voyages had a total of 26,892 tons, against 19,692 tons in the preceding week, and 18,468 tons in the same week of last year. Many kinds of iron showed an increase but the steel imports, taken altogether, were more than double those of a year ago.

The Reported Discovery of Ironstone at Conisborough.—The explorations in connection with the recent discovery of ironstone at Conisborough have now ceased, and many different accounts are now given as to the results. Although there is an abundance of ironstone, an inspection of the sites of the trial shafts, and the material thrown out, would seem to show that it is too mixed up with the other strata to allow it to be profitably worked in competition with the Lincolnshire ironstone. The operations have been carried on with considerable vigour by the lord of the manor.

Miners and Scientific Improvements.—The miners of Messrs. Pipe and Pearson's (Limited), Haigh Moor Pit, Altofts, near Normanton, have struck work. After the colliery explosion at the Silkstone pit of the company, the management decided to discontinue the use of blasting in both the Silkstone and Haigh Moor Mines. In order to effect the introduction of gelatine instead of powder, the miners were supplied gratuitously for three months, gelatine being deemed by scientific authorities less dangerous than powder. The three months having expired, the miners have been paying for the gelatine they used, just in the same way as they previously paid for powder. The miners are now complaining that the use of gelatine is costing them double the amount they formerly paid for powder, and practically means a reduction in their wages of several shillings per week. In consequence of this the Haigh Moor men have struck work.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the market was well attended, but business was dull and prices were weaker. No. 3 Cleveland pig iron for early delivery was offered in second hands at 35s. 3d. per ton, but makers still held out for higher figures. The shipments of pig iron at Middlesbrough during the month of February were fairly good for the time of year, having exceeded 52,000 tons. It is, however, believed that the stocks for the month will show an increase, and this is having a depressing effect upon the market. Reports from other iron centres continue fairly satisfactory, and with the opening of navigation a further improvement is anticipated. Hematite pig iron is quiet at 47s. 6d. per ton for Nos. 1, 2, and 3 f.o.b. east coast ports. Manufactured iron is unchanged. Plates are quoted 4*l.* 15s., angles 4*l.* 10s. to 4*l.* 12s. 6d., steel ship-plates 6*l.* 5s. to 6*l.* 10s., and angles 5*l.* 15s. to 5*l.* 17s. 6d. per ton, less 2½ per cent. at works. Steel rails are 4*l.* 5s. to 4*l.* 7s. 6d. f.o.b.

Engineering and Shipbuilding.—Engineers and iron-founders are getting more orders, and some substantial contracts have been recently placed in the Cleveland district on foreign account. A week ago Messrs. R. and W. Hawthorn, Leslie, and Co., St. Peter's, Newcastle-on-Tyne, launched a fine steamer named Le Morbihon. This vessel is built for the Compagnie Générale Transatlantique, and is 230 ft. by 33 ft. by 21 ft., and is fitted with triple-expansion engines of 1000 indicated horse-power. A few days ago Messrs. Austin and Sons launched the Verulam, a vessel classed 100 A 1 at Lloyd's, 1660 tons gross register, and fitted with triple-expansion engines and steel boilers by Blair and Co., of Stockton. Messrs. John Readhead and Co., of South Shields, have launched the Tockwith, built to the order of Messrs. Groves, Maclean, and Co., of West Hartlepool. She is to carry about 3200 tons deadweight, is intended for the Indian and American trades, and is fitted with triple-expansion engines and steel boilers.

The Steel Trade.—The steel trade continues very busy, and further extensions are going on in different parts of the North of England to meet the growing requirements. Messrs. Bolckow, Vaughan and Co., of Middlesbrough, are recommended by their directors, who met in London a few days ago, to pay a dividend for the year ending December 31 last at the rate of 2½ per cent. per annum. Their works are now well occupied, and the steel works have orders on hand which will keep them busy for months. It is believed that the next dividend will be better than the last.

The Coal and Coke Trades.—Owing to the continued strike of pitmen in Northumberland the Durham collieries and coke ovens are more active, and prices are firm. There is no indication of the strike terminating, and large orders for coal have gone to Cardiff.

More Salt Boring at Middlesbrough.—The production of salt in the Middlesbrough district is now very considerable, and it is still extending. While additional boreholes are being sunk by the companies already producing salt at Port Clarence and Haverton Hill, the owners of the Middlesbrough Estate, Limited, have commenced to sink a bore-hole for salt in a field adjoining the Guisborough branch of the North-Eastern Railway near the North Ormesby Toll Bar at Middlesbrough. The contract for sinking is with the Cumberland Diamond Boring and Tunnelling Company.

LIVERPOOL ENGINEERING SOCIETY.—The usual fortnightly meeting of this Society was held at the Royal Institution, Colquitt-street, Liverpool, on February 23rd, Mr. John J. Webster, M. Inst. C.E., president, in the chair. A paper was read by Professor Hele Shaw, "Upon the Theory of the Steam Engine." The meeting on March 9th will be devoted to the discussion of the paper.

TELEGRAPH EXPENDITURE.—A Parliamentary paper has been is used showing the gross amount received and expended on account of the telegraph service during the year ended March 31, 1886. The total amount received was 1,832,401*l.*, showing a balance of expenditure over receipts of 45,137*l.* The chief item of receipt is 1,974,852*l.*, the gross amount received by the office in respect of telegraphic messages, rentals of private and special wires, which has to be reduced by 229,796*l.*, paid to submarine telegraph companies and moneys refunded. The chief item of expenditure is 1,733,104*l.* expended by the office in respect of salaries, rent, and maintenance. The balance already mentioned by no means shows the real excess of expenditure over receipts, for a sum of 326,417*l.* has to be added as one year's interest on the 10,880,571*l.* of securities, and this makes the deficiency for the year 371,654*l.*, which may be compared with 362,767*l.* of the previous year. Altogether the deficiency from the beginning of 1872 to March 31, 1886, has been 2,553,009*l.* The only year when anything like a balance occurred was in 1881, when the deficiency was only 984*l.* This increased next year to 112,524*l.*, and has gone on rising (with a very considerable leap between 1883 and 1884) until the present year, which is the highest of all.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, February 18.

TO-DAY'S quotations for forge iron are, for ordinary, 18.50 dols., and for special, 20 dols. Standards are selling at 19 dols. where they can be had. No. 2 foundry iron is wanted at 19 dols. and 19.50 dols., and No. 1 is worth about 22.50 dols. English Bessemer could be sold freely at 20.50 dols. to 21 dols., and even at 21.25 dols. Two or three large blocks of material have been contracted for. Small orders have gone out for bridge iron and plate, and brokers are now pressing their claims for foreign makers with prospects of success which will involve the importation of large quantities of bridge-building material. Some inquiries have been made for merchant bar iron also. Large lots of steel rail blooms will be imported when prices drop 1 dol.; at least, offers have been made at about the figure. The brokers in New York and Philadelphia have had a good many inquiries for foreign material, and but for the advance would have, they say, secured contracts for over 100,000 tons. They expect to sell this much yet for rolling mill purposes. The rolling mills throughout the United States are all busy, and the capacity will be extended as rapidly as possible. Furnace capacity is now estimated at nearly 20,000 tons of pig iron per day. Fifteen to twenty new furnaces will be building within six months. They will be of the largest capacity, and nearly all of them will be located in Northern Alabama. Great activity prevails in that new iron section, and real estate is advancing in value rapidly. The vast coal and ore deposits of that section are in the hands of powerful syndicates of capitalists who anticipate great results from this control. Cheap deposits of ore and coal will be worked in Pennsylvania, and two or three new furnaces will be built as rapidly as it is possible, to turn out iron at a cost of 10 dols. per ton. A syndicate has just completed securing possession of a valuable mineral tract in Virginia, where it is estimated that iron can be made at 8.50 dols. per ton. Extensive railway building projects have been brought to the attention of capitalists within a few days, the object being to develop very valuable mineral and timber resources, through which the projected railroads will pass. To all appearances the heavy demand for iron and steel will continue throughout the year. Prices have reached their highest point for the present, excepting in steel rails. Rails were sold this week at 40.50 dols., and some mills are asking 41 dols. because of their inability to take orders at any price.

MESSRS. BULLIVANT AND CO.'S NEW WIRE ROPE WORKS.

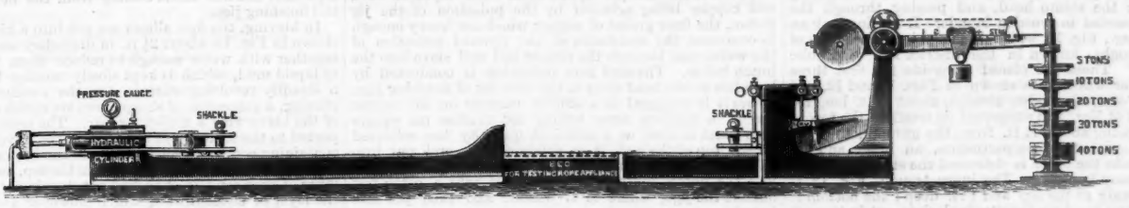
ON page 515 of ENGINEERING of December 5, 1884, we gave an account of Messrs. Bullivant and Co.'s new and extensive works building at Millwall, E., and their various manufactures. We now propose to supplement this notice by a brief description of these works in their present completed form, reference being made to the sectional plan on the opposite page, which illustrates the general arrangement of the different manufacturing departments.

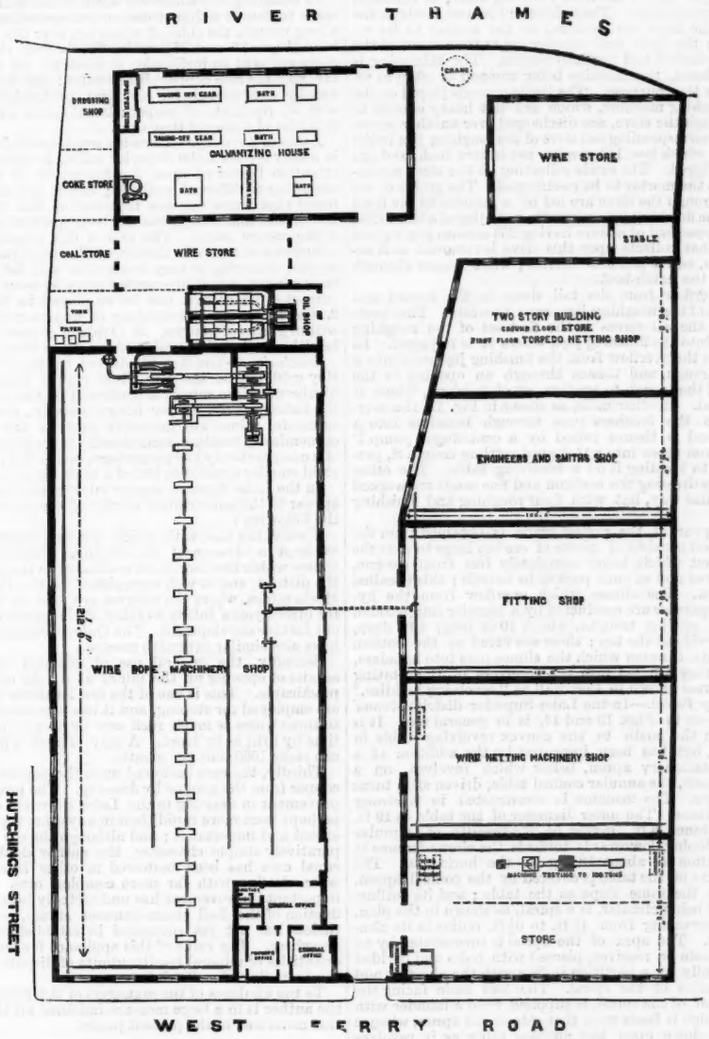
Upon reference to this plan, the disposition and spacious nature of the various shops will be apparent, *i.e.*, the provisions for wire pickling, galvanising, reeling, and working, the strand-making and rope-forming departments; as also the fitting and smiths' shops, stores, wire netting, and torpedo net factories, &c. A general description of wire ropemaking, as carried out at these works, for the various purposes of the trade, was given in the number of our journal already referred to. Wire ropes are extensively manufactured at these works for marine, mining, tramway, cranes, lifts, and other analogous purposes, according to modern improvements. The strand-making and rope-closing machinery provided upon these premises are chiefly according to recent approved designs and derive their motion from suitably arranged shafting, pulleys, and belting, driven from the main engines in a manner that will be understood upon reference to the illustration. Amongst these appliances are six, twelve, eighteen, and twenty-four bobbin-stranding machines, and some of the largest "rope closing" machinery in existence, *i.e.*, capable of making a rope up to about 20 in. in circumference, and closing about 25 tons of wire in one length.

Wires of iron or steel used at these works, in different manufactures, vary from 0.012 in. to .128 in. L.W. gauge. Steel wire ropes are here manufactured to a considerable degree of flexibility and strength, some having a breaking strain of about 150 tons per square inch of sectional area. The wire strands are usually formed round hemp cores, previously soaked in tar or oil according to requirements. Hawsers and fixed wire ropes are usually composed of galvanised wire strands, whilst haulage or running ropes are made of black wires, subsequently tarred.

In another part of the rope or cable factory is situated modern submarine cable plant and machinery, &c. In another department, upon the east side of the works, is provided a large number of wire net-

MESSRS. BULLIVANT AND CO.'S WIRE ROPE WORKS, MILLWALL.





ting machines, by which many miles of netting are manufactured daily, the description and functions of such machines varying to meet the requirements of the trade. This class of netting is made of ordinary black annealed iron wire, and is subsequently galvanised, the gauges of the wires and sizes of the meshes varying according to requirements.

A special department is set aside for the manufacture of torpedo nets—a speciality to which this firm has devoted much attention with considerable success; the principal vessels of most of the British and European navies being now provided with such protective appliances. In practice, such provisions have been found to be effectual. These nets are composed of a combination of woven steel wire grummets, secured by small welded rings, capable of resisting an impact of about 6 to 8 tons, each complete net measuring about 15 ft. by 20 ft. In practice two of such nets are supported between light steel booms, capable of being swung in vertical and horizontal planes and projecting over the vessel's side. Each of these booms is fitted with runners and tackle gear, so that the nets may be hauled out and set in position in a few minutes. Intermediate guys are also provided, so as to prevent boats effectually charging the nets.

The manufacture of these nets is carried out according to a patented process and production held by this firm. Careful attention is bestowed at these works upon all materials and workmanship employed in the various manufactures. All wire used on the premises is previously tested for the requisite tensile, torsional, and elastic strengths, to meet the various requirements to which they are to be applied. The ropes, &c., made of such passed or accepted wires, are afterwards tested for any required aggregate strength and efficiency by submitting lengths to practical trials in an hydraulic testing machine of a somewhat ingenious character. A side elevation of this hydraulic direct-acting lever machine is shown above, and consists of an arrangement of compound levers, to which a desired (variable) load can be applied, in combination with an hydraulic ram.

The horizontal lever of the first part of the apparatus is mounted upon a suitable fulcrum, the short end thereof being fitted with an adjustable counterweight, whilst the opposite extremity—or long arm—is provided with means of attaching weights, capable of exerting from 1 cwt. to 100 tons upon the terminal or testing shackle of the apparatus. The various weights that may be applied to exert any desired or requisite resistance are indicated in the illustration. A scale of 1 to 5 tons is also provided upon the horizontal lever and upon which a travelling weight—actuated by appropriate gearing—may be caused to traverse and exert a force in proportion to the compass of such scale. The terminal shackle of this portion of the contrivance is connected with the horizontal lever by means of links, a bent or bell-crank lever and vertical connecting-rod, mounted on suitable fulcra. The ram or plunger of the hydraulic apparatus is provided with a crosshead to which rods are attached, and terminating at their other ends with a holding shackle.

It will now be understood, that when it is desired to ascertain the strength of any rope, a convenient section or length thereof is fastened between the securing shackles of the ram and lever arrangement when the approximate expected breaking load is brought into connection with the long arm of the horizontal lever and hydraulic pressure is then applied. The requisite pressure is raised and maintained in the cylinder of the latter part of the apparatus by means of an ordinary hydraulic pump, worked either by hand or a gas motor, and by which the ram and its connections are forced outwards and away from the lever mechanism, thus exerting a corresponding straining force upon the connecting piece of rope subjected to testing. Such force and strain are continued until the rope breaks or the resisting loads are overcome, and the horizontal lever raised against a stop controlling its movement. Thus by increasing the weights on the levers, the breaking strain of any rope may be accurately ascertained. The hydraulic cylinder is fitted with a pressure gauge, which indicates the force exerted, when a rope is thus ruptured or parted. The auxiliary loading of the horizontal lever from 1 to 5 tons, or integral parts of same, is effected by moving the travelling weight along it, as before mentioned.

It may be mentioned that these works stand on a convenient site of nearly three acres, situated on the north bank of the Thames, and are capable of producing about 500 tons of rope per month.

Examples of the uses of this firm's flexible steel wire ropes have already been given in our prior notice upon the subject, and therefore it is now sufficient to add that further recent exemplifications may be quoted in connection with the 100-ton shear legs of Messrs. Denny and Co., Dumbarton, fitted with eight parts or folds of a 5-in. wire rope; the Day and Summer's slipway, at Ayr, provided with a 12-in. rope, having a breaking strain of about 400 tons; the Peninsular and Oriental Steam Navigation Company's 6-in. hawsers; the flexible traction ropes of the Highgate Hill cable tramway and similar ropes for the Melbourne cable tramways, being five miles in one length and weighing nearly 24 tons. Messrs. Bullivant and Co. have also the contract to supply all the erection plant—*i.e.*, cables, pulleys, and running gear, &c.—for the Sukkur Bridge, about to be erected over the Indus, a clear span of 790 ft., and connecting the Karachi and Quetta railways.

LAKE SUPERIOR COPPER MINING.

*On Copper Mining in the Lake Superior District.**

By Mr. EDGAR P. RATHBONE, of London.

(*Concluded from page* 180.)

III.—SYSTEM OF ORE-DRESSING, AND MACHINERY EMPLOYED.

The object of ore dressing is to separate as far as possible the small percentage of valuable metal occurring in the ore from the worthless matrix or gangue with which it is found associated. In the Lake Superior district metallic copper is the only product of value; and the dressing process consists simply in separating it from the gangue, and concentrating it to the highest degree of purity practicable. Thus whilst the average percentage of copper in the rock mined in this district does not generally exceed 1 to 2 per cent., the dressed product sent from the mill to the smelting works contains on an average about 80 per cent. of copper. In describing the system of dressing followed in a Lake Superior copper mill it will be sufficient to refer to the machinery required to dress the ore from a single stamp, as shown in Fig. 11, page 206; and the main feature of the process may be said

* Paper read before the Institution of Mechanical Engineers.

to consist in applying to copper ore the principles and the machinery already employed elsewhere in the dressing of tin and lead ores.

Hydraulic Separators.—The stream of sands issuing from under the stamp head, and passing through the screens, is carried in wooden launders L inclined at an angle of 5 deg., Fig. 11, which discharge into three rows of settling troughs, known in the district as "hydraulic separators." These are placed alongside the first three sets of jigs or washers, as shown in Figs. 11 and 12, and consist of V-shaped wooden troughs, about 16 ft. long for a double set of jigs, and supported on trestles, the top of the trough being about 4½ ft. from the ground; they are constructed with two compartments, an inner and an outer, and into the inner is delivered the stream of sands from the stamp launders. The inner trough, Fig. 12, is about 1 ft. wide at the top and 1 ft. deep; the bottom is 1 in. wide, and has four longitudinal slots cut in it, each 1 in. wide and varying from 4 in. to 9 in. in length, the longest being situated nearest to the delivery from the stamp launders. The slots open into the outer trough, which extends on each side of the inner, and is about 1⅞ ft. wide at top and 1⅝ ft. deep; it has an angular channel, with four openings in it close to the bottom, which are fitted with 1 in. discharge pipes. The outer trough is kept nearly full of water by a 1½ in. pipe from the water main; and the rough separation of the larger pieces of mineral from the minuter particles known as "slimes" is effected by the action of the water in the following manner. The height of the water in the outer trough being maintained at a few inches higher level than the stream of sands flowing along the inner trough, the consequent upward current of water through each of the four slots in the bottom of the inner trough permits only those pieces to drop through them which are heavy enough to overcome the resistance encountered from the rising current. The heaviest and coarsest bits fall through the largest slot, the next through the second, and so on for the third and fourth; and all these are discharged from the bottom of the outer trough through the pipes leading to the jigs. The finest particles of sand, however, constituting the slimes, being too light to overcome the upward current, flow out from the end of the inner trough into other launders, and thence into settling troughs. A rough separation of the sands into coarse, medium, and fine is thus effected in the first stage of dressing.

Some 75 per cent. of the total amount of rock crushed by one stamp head, or say 150 tons, assuming the stamp to crush 200 tons per day, is thus removed from the stream of sands, and is subsequently dealt with by the jigs. The size of the bits varies from over $\frac{1}{8}$ in. down to $\frac{1}{32}$ in., more than 40 per cent. being less than $\frac{1}{16}$ in. Of the sands thus separated from the slimes, about 65 per cent. are classified as coarse, 22 per cent. as medium, and 13 per cent. as fine.

Jigging.—The process of jigging consists in sorting into layers, according to their varying specific gravity, an aggregation of particles differing both in shape and density, by means of the vertical pulsation produced among them by the aid of water; according to the construction of the machine employed, the pulsation is produced either by the water moving vertically through the stuff, or by the stuff moving vertically through the water. In a Lake Superior copper mill the jigs are arranged in sets alongside the hydraulic separators, as shown in Fig. 11, the first row in each set being called "head sieves," and the second row in each set "tail sieves." For each stamp head there are as a rule three sets of head and tail sieves, each set with its own hydraulic separator; and these are known as the "roughing" jigs. They are succeeded by two or more similar sets called "finishing" jigs, which are not directly connected with a hydraulic separator. All the jigs are of similar construction, and are worked in the same way, the only difference being in the fineness of the mesh of the sieves, which varies from 10 to 30 holes per lineal inch or from 100 to 900 holes per square inch.

The jigs in general use in the district, as shown in Fig. 12, are those commonly known as the "Collom washer," being the invention of Mr. John Collom (see Proceedings, 1873, page 135). Each is constructed in a rectangular wooden tank, about 7 ft. long, 3½ ft. wide, and 2½ ft. high, with frames of 2½ in. stuff. Up to about 18 in. from the bottom of the tank it is equally divided into two compartments or "hutches," having inclined sides and a 1½-in. discharge pipe from the bottom. About 6 in. from the top in each hutch is fixed a horizontal wire sieve, 3 ft. long and 2 ft. wide, which is kept covered with a bed of coarse sized copper, varying in thickness from ½ in. to 1½ in. The two hutches are kept filled with water by 1-in. pipes entering about 9 in. from the bottom and connected with the 1½-in. water main. In the middle of the upper part of the tank are two other compartments, each 2 ft. by 1½ ft. and 1 ft. deep, the bottom of each being left open to the two hutches respectively. In each compartment works a loosely fitting wooden piston, on which stands a piston-rod about 18 in. high, steadied in guides; on the top of the rod is screwed a nut, below which is a spiral spring, adjusted to aid in lifting the piston after it has been depressed by the arm of the rocking lever overhead. The rocking lever is worked by a connecting-rod and crank from a 20-in. belt pulley, and depresses each piston alternately about ½ in., the extent of depression being regulated by the adjusting nut on the top of the piston-rod. The piston is raised again by the joint lifting action of the water beneath it and of the spiral spring above it. The number of pulsations is about 120 revolutions per minute, varying according to the fineness of the stuff to be jigged. Two rocking levers are coupled by a rod, so as to be worked by one pulley.

These jigs are known as "bed jigs;" and their action and mode of working are as follows: The coarse sand issuing from the first spout of the hydraulic separator flows over an apron on to the head sieve of the first set of roughing jigs. Upon the stratum of copper forming the bed of the sieves, a layer of several inches thick is soon deposited of coarse sand, too large to pass through the sieve of 100 meshes per square inch. The layer of sand and copper being agitated by the pulsation of the jig piston, the finer grains of copper which are heavy enough to overcome the resistance of the upward pulsation of the water pass through the copper bed and sieve into the hutch below. The stuff here collecting is conducted by launders to the head sieve in the first set of finishing jigs, where it is re-jigged in a similar manner on the copper bed of a medium sieve having 256 meshes per square inch; and as soon as a sufficient quantity has collected on the top of the bed, it is skimmed off, and put into barrels. The still finer ore which falls through this sieve into the hutch beneath is discharged into a catch-box outside the jigs, where it is washed and then put into barrels.

The layer of coarse sand and grains of ore which collects on the copper bed of the head roughing sieve, is skimmed off as it accumulates. The lighter and coarser sands at the top of the layer are returned to the mortar to be re-stamped; the finer and heavier ore at the bottom of the layer is collected and put into barrels. The skimming is done by hand, the machine being stopped as often as required for that purpose. The lightest sands jigged on the head roughing machine, which are not heavy enough to pass through the sieve, are discharged over another apron on to the corresponding tail sieve of the roughing jigs in the same set, which has 144 meshes per square inch, and are there re-jigged. The sands collecting on the sieve are returned to the mortar to be re-stamped. The grains of ore falling through the sieve are led by a launder to the head sieve of the finishing jigs, where they are jigged a third time on the copper bed of a sieve having 256 meshes per square inch. What collects upon this sieve is removed as it accumulates, and is put into barrels; what passes through runs into the catch-box.

The overflow from the tail sieves in the second and third sets of the roughing jigs, runs to waste. The overflow from the tail sieves in the first set of the roughing jigs runs into the finishing jigs, where it is re-jigged. In some mills the overflow from the finishing jigs runs into a settling trough, and thence through an opening in the bottom of the trough to another set of finishers, where it is re-jigged. In other mills, as shown in Fig. 11, the overflow from the finishers runs through launders into a cistern, and is thence raised by a centrifugal pump P through iron pipes into a V-shaped settling trough S, preparatory to treating it on a revolving table. The other sets of jigs dressing the medium and fine sands are worked in a similar way, but with finer roughing and finishing sieves.

The copper of the richest grade is obtained from the mortar, and consists of pieces of ore too large to pass the screens, but which, being completely free from gangue, are removed and at once packed in barrels; this is called cover work. The slimes which overflow from the hydraulic separator are conducted by a launder into wooden V-shaped settling troughs, about 10 ft. long, 4 ft. deep, and 4 ft. wide at the top; these are fitted at the bottom with spouts, through which the slimes pass into launders, whereby they are led into the receivers of the rotating tables, better known in Cornwall as "revolving buddles."

Rotating Tables.—In the Lake Superior district Evans' table, shown in Figs. 13 and 14, is in general use. It is similar in the main to the convex revolving table in Cornwall, but has been improved by the addition of a central stationary apron, below which revolves, on a vertical shaft, the annular conical table, driven at 1½ turns per minute. The machine is constructed in a strong wooden frame. The outer diameter of the table is 19 ft. and the inner 8 ft., giving 5½ ft. breadth of annular surface, sloping downwards towards the circumference at an inclination of about 12 deg. to the horizontal. The open centre of the table is covered by the conical apron, which has the same slope as the table; and its outline, instead of being circular, is a spiral, as shown in the plan, Fig. 13, increasing from 4½ ft. to 6½ ft. radius in its complete turn. The apex of the apron is surmounted by an annular basin or receiver, pierced with holes and divided diametrically by a partition in line with the shortest and longest radius of the spiral. The half basin facing the shorter half of the spiral, is supplied from a launder with slimes, which it feeds upon that side of the apron, whence they flow down upon the annular table as it revolves beneath. The other half basin, facing the longer half of the spiral, is supplied with clear water, which flows thence over that side of the apron, and down upon the annular table, washing out the tailings or lighter and poorer part of the slimes, of which the middles and heads or heavier and richer portions remain deposited upon the table, and are carried round towards the longest radius of the spiral apron. As the radius of the apron increases in the same direction in which the table revolves, the slimes and the water are delivered upon the table gradually nearer and nearer to its outer edge. The tailings washed off the table are caught in a circular launder running round underneath its outer edge. Towards the end of the revolution, shortly before arriving at the longest radius of the apron, a pipe stretches radially across the table, having its outer end bent back obliquely over the table, and perforated with holes discharging jets of clear water, by which the middles or medium slimes are washed off into a catch-box fixed alongside that part of the table. Finally the heads or richest portion of the concentrates, which still cling to the table and succeed in passing these jets, are washed off into a separate catch-box by a still stronger jet at the very end of the revolution, leaving the table quite clean for starting upon its next round.

Kieving and Buddling.—The products of the rotating tables are seldom rich enough to be sent straight to the smelting works, and therefore require to undergo further concentration, which is generally effected by means of the two processes usually employed in Cornwall and known as "kieving" and "buddling." The same is the case in regard to many of the products of the jigs, more especially the fine sands coming from the hutches of the tail finishing jigs.

In kieving, the fine slimes are put into a kieve or tub, shown in Fig. 15, about 2½ ft. in diameter, and 3 ft. deep, together with water enough to reduce them to the state of liquid mud, which is kept slowly moving by means of a steadily revolving stirrer. On the conclusion of the stirring, a succession of sharp blows are struck on the sides of the kieve with a mallet or bar. The tremor thus imparted to the semi-liquid mass causes the heavier particles containing copper to settle down to the bottom. After a short time the water is run off from the top, and the upper layer of poor sand is shovelled out, leaving at the bottom the layer of concentrates, which however are frequently not rich enough yet for smelting, and have consequently to be buddled.

In buddling, the slimes are again mixed with water, and made to flow in a thin stream over a spreading apron into a long trough, the sides of which are over 2 ft. high at the head (Figs. 16 and 17), while the bottom slopes gently downwards at an inclination of 3½ deg. At the head of the box the rich copper slime settles; and this deposit is usually rich enough for smelting, containing as it does over 30 per cent. of copper; but if still not rich enough, it is kieved a second time over.

Losses in Dressing.—There is a considerable loss of copper in nearly all the Lake Superior mills, in spite of all the attention bestowed upon the treatment of the tailings according to different methods; and it has usually been found that extra expense incurred in that direction for labour and machinery, has not been justified by the value of the copper saved. The loss is due principally to the occurrence of copper in the three following forms: 1. Float copper, occurring in very fine grains and flat scales free from gangue, which are carried away by even the weakest current of water that can be employed in the dressing. 2. Included copper, consisting of fine particles included within grains of gangue. 3. Oxide of copper, which may be either included in grains of gangue or found free.

Conclusion.—The fact illustrated by the St. John del Rey gold mines, the Rio Tinto copper mines, and the Mechernich lead mines, is confirmed by the experience of the Lake Superior copper mines, namely, that the most successful mines are generally such as are capable of economically treating exceptionally large quantities of ore of a comparatively low percentage, rather than those which yield smaller quantities but of a higher percentage.

In the Lake Superior copper mining, the features which appear to the author most worthy of special attention are the following:

Firstly, the care with which the exploratory workings are kept in advance of the stoping. This is one of the causes which has been most conducive to the prosperity of the district, and is well exemplified in the Calumet and Hecla mines, where the reserves are said to be sufficient for fifteen years' future working at the present rate without further development. The Quincy and Atlantic mines have also similar extensive reserves.

Secondly, the general use of machine drills, which admits of opening up the mines at a rate otherwise impracticable. This is one of the few localities where drills are employed for stoping, and it has been found that two to three times as much rock can be stoped in the same time by drill as by hand. A pair of men with one drill can stope 1000 tons per month.

Thirdly, the care bestowed upon the separation of the copper from the gangue by dressing. The progressive improvement in dressing in the Lake Superior district has perhaps been more rapid than in any other region of equal extent and importance; and although the ore is of a comparatively simple character, the author doubts whether equal care has been bestowed in other localities, even when dealing with far more complex ores. The most important improvement has undoubtedly been the introduction of the Ball steam-hammer stamp, which nevertheless has not yet succeeded in establishing a footing elsewhere. The value of this appliance for treating large quantities of mineral hardly admits of dispute as regards the Lake Superior district.

To the kindness of the managers of the principal mines the author is in a large measure indebted for the information contained in the present paper.

NEW BRUNSWICK.—New Brunswick has now 1379 miles of railway.

ERRATUM: THE STEAM TUG "POWER."—In our account last week of the engines of the steam tug Power, built by Messrs. Newall, and Co., of Bristol, the consumption of coal in towing a 1000-ton ship was, by an omission, stated to be 6⅔ tons per hour, instead of per day of twenty-four hours.

AUSTRALIAN STEAM NAVIGATION.—The directors of the Australian Steam Navigation Company have accepted an offer of the Queensland Steam Shipping Company for the purchase of their fleet. The amount of the purchase-money is 200,000*l.*, but a large quantity of stores belonging to the various steamers, and some new machinery, are also to be taken at a valuation. The purchasing company will thus have to pay altogether between 220,000*l.* and 230,000*l.* The purchase-money will, in the first instance, be raised in England. The Queensland Shipping Company will be reorganised almost immediately under the name of the United Australian Steam Navigation Company, and the capital will be increased so as to meet the outlay now being incurred, and to allow of the construction almost immediately of two boats of a first-class type for the principal service to be maintained by the company.

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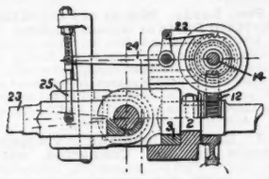
STEAM ENGINES.

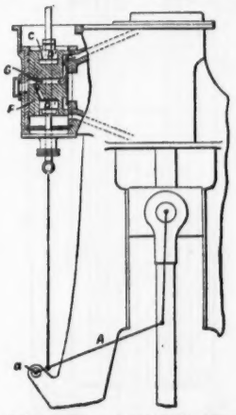
11,717. J. G. Joicey and M. Watson, Newcastle-upon-Tyne. Improvements in Governing Apparatus for Steam or other Engines [8*d.* 3 *Figs.*] October 1, 1885.—Inventors claim for the purpose of controlling the speed of steam engines or other prime movers, the combination of parts consisting of a governor or other automatic mechanism controlling the admission of steam or other fluid into an auxiliary cylinder with a cataract cylinder controlling the action of the auxiliary cylinder. (*Sealed October* 8, 1886).

1768. G. M. Park, Blackburn, Lancaster. Rotating Pistons. [8*d.* 5 *Figs.*] February 6, 1886.—This invention has for object to cause rotation of pistons in steam engines or pumps to obviate the unequal wear that occurs where the weight of the piston rests upon a part of the circumference. For this purpose the crosshead is fitted with a ratchet device, by means of which motion derived from the connecting-rod is applied to slowly rotate the piston-rod and piston. The rod 1 of the piston to which rotary motion is to be imparted, is provided with a neck



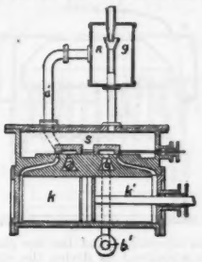
or collar 2, which enters into the crosshead 3, so that whilst endwise movement of the piston rod is prevented, it may be rotated therein. The motion of the connecting-rod 23 is transmitted by a link 25, lever 24, and pawl 22, to a ratchet wheel 14, which operates an eccentric boss engaging with a concentric wheel that advances only one tooth in one revolution of the eccentric boss. Upon the axle of the concentric wheel is keyed a worm that operates a wormwheel 12 fixed on the piston-rod, so that a very slow rotation is constantly imparted in an intermittent manner to the piston rod while the engine is running. (*Sealed February* 15, 1887).

2000. D. Joy, London. Improvements in Valve Gear for Motive Power Engines. [8*d.* 4 *Figs.*] February 11, 1886.—According to this invention the engine valves receive a part of their motion from some moving part of the engine, whilst the remaining part of the motion is imparted to the valve by the pressure of the fluid actuating the engine. In the modification illustrated, motion is given to the main valve F by a lever A having a fixed fulcrum *a*, which will move the valve through that part of its stroke required for "lap" and "lead," and the remainder of the stroke for opening the port is obtained



by moving the main valve F or a part of it, forward through the action of a small cylinder C which may form a part of the main valve and receive its motive power from the steam admitted already as "lead" into the port of which it is to complete the opening. This steam passing along the opening G in the valve to the piston D^1 of the small cylinder C, gives motion to the valve to fully open the port, the motion for exhaust being reversed. The small cylinder C may also be provided with its complete valve gear, and may be arranged outside the main valve casing. (*Accepted December* 14, 1886).

2162. W. Schmidt, Braunschweig, Germany. Improvements in or Relating to Steam Engines. [8*d.* 5 *Figs.*] February 15, 1886.—The improvements consist in bringing the steam into action on each side of the engine piston or pistons consecutively in such a manner that before each passage of the steam which has done work on one side of the piston, to the other side, a partial suction compression and regeneration of the steam takes place, by means of an ejector, while the steam volumes not sucked off pass for further utilisation and expansion into the cylinder or cylinders. The figure illustrates the application of this invention to an engine with a single cylinder. The steam is caused to act differently on both sides of the piston, the left side *k* taking steam from the valve-box *s*. After the steam has partly expanded and given off work, it passes through a channel *a* and a pipe a^1 into a reservoir R, where it is com-

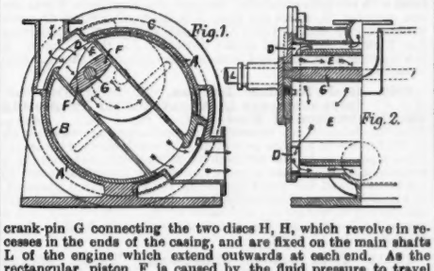


pressed again by the steam injector pipe *g* and forced into the box *s* for further utilisation in the cylinder. The injector pipe is fed from the boiler. The steam taken from the valve box *s*, and giving off work on the right side k^1 of the piston, exhausts through a channel *b* and pipe b^1 into the air or a condenser, and is not compressed again like the steam which has been utilised on the left side of the piston. (*Sealed February* 18, 1887).

9364. H. Davey, Leeds. A Governor and Expansion Valve for Engines Worked by Steam or other Elastic Fluid. [6*d.* 4 *Figs.*] July 19, 1886.—Inventor claims in combination with a governor spindle driving through a spring a rotating expansion valve and a casing containing pivotted segmental weights, a pinion on the spindle gearing with the weights, in such a manner that the outward movement of the weights due to centrifugal force causes the valve to advance relatively to the spindle, so as to cut off supply at an early period. (*Sealed October* 26, 1886).

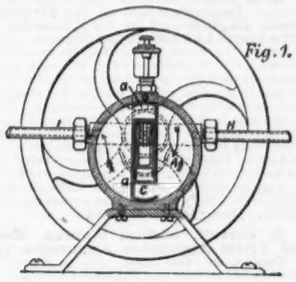
ROTARY ENGINES.

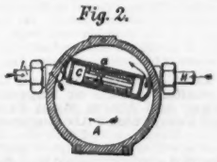
8700. J. Brockie and M. W. W. Mackie, London. A Rotary Engine Applicable as a Fluid Meter or Pump. [8*d.* 4 *Figs.*] July 18, 1885.—Within a cylindrical casing A is fitted a cylindrical block B provided with a flange C in which are cut the steam and exhaust slots D communicating with the slot or cylinder E. The cylindrical block B is free to revolve within the casing, and in the block, extending its whole length and nearly along its whole diameter, is a slot E which is virtually the working cylinder of the engine, and in which is fitted a reciprocating rectangular piston F. Through this piston passes a



crank-pin G connecting the two discs H, H, which revolve in recesses in the ends of the casing, and are fixed on the main shafts L of the engine which extend outwards at each end. As the rectangular piston F is caused by the fluid pressure to travel along the slot E in the cylindrical block B, the crank G is caused to revolve. Shallow slots are cut in the block at right angles to the main aperture slot E, and engaging in these slots are short crank-pins provided with antifriction rollers, for the purpose of obviating all tendency to jamming when the main crank-pin G is at the dead points, that is, when the axis of the crank-pin is in coincidence with the axis of the casing. (*Sealed October* 22, 1886).

10,666. W. Lloyd Wise, London. (*V. Popp, Paris.*) **Improvements in Rotary Motors to be Operated by Fluid Pressure.** [11*d.* 10 *Figs.*] 1886. [December 15, 1885.] The motor comprises a cast-iron cylinder A provided with a tube I for exhausting the compressed air admitted by the tube H. The piston C consists of two similar steel wedges *a*, *a*, sliding one within the other, and stayed apart by a rectangular guide-piece through which passes the shaft. The shaft is furnished with an



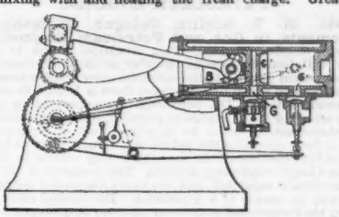


exhaust opening to avoid the compression of the air in the empty spaces of the wedges. At the commencement of its stroke the piston occupies the position shown in Fig. 2, the inlet port is slightly open, and allows air to penetrate into the upper segment of the cylinder, the exhaust port is wide open and connects the lower segment with the atmosphere. On the fluid entering under pressure by the tube H it flows into the upper portion of the cylinder, and as the axis of the piston is situated at a point one-third of the diameter of the cylinder from the circumference, the fluid pressure forces the piston to perform half a revolution. As soon as this half-revolution is accomplished, the exhaust port re-opens and allows the air to escape, but at this moment the compressed fluid no longer enters the first segment of the cylinder, but commences to act on the other piston face, thus forcing it to complete its revolution around its axis with or without expansion. (*Sealed December* 21, 1886).

GAS ENGINES.

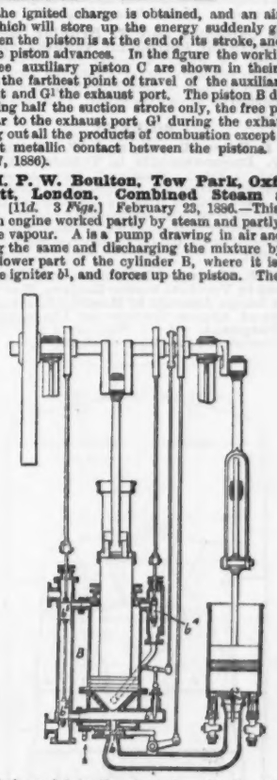
11,230. G. F. Rodfern, London. (*G. Smyers, Brussels.*) **Improvements in Gas Engines or Engines Actuated by the Explosion or Combustion of Mixed Gas or Vapour and Air.** [8*d.* 6 *Figs.*] September 22, 1885.—This invention relates to the construction and use with petroleum motors of an apparatus for generating petroleum vapour, consisting of a combined atomiser and vaporiser forming a double receiver. One of these receivers serves to receive a quantity of small pieces of copper heated by the second receiver through which are passed the products of combustion for the purpose of heating the pieces of copper, and thus cause them to heat and convert into vapour the petroleum for actuating a piston by expansion and deflagration. (*Sealed October* 22, 1886).

2174. R. Skene, London. Improvements in Gas Engines. [8*d.* 6 *Figs.*] February 15, 1886.—The improvements consist in the use of an additional charge of atmospheric air or vapour confined in a closed chamber, preferably part of the cylinder, behind a freely moving auxiliary piston, by means of which it is separated air-tight from the explosive charge; the additional air or gas charge being thus compressed like, and to the same pressure as, the explosive charge, during the compression stroke, and also upon explosion of the latter. This has the effect of expelling the products of combustion and preventing them from mixing with and heating the fresh charge. Greater ex-



pansion of the ignited charge is obtained, and an air cushion is provided which will store up the energy suddenly given out on ignition when the piston is at the end of its stroke, and give it up again as the piston advances. In the figure the working piston B and the free auxiliary piston C are shown in their respective positions at the farthest point of travel of the auxiliary piston C. G is the inlet and G^1 the exhaust port. The piston B draws in gas and air during half the suction stroke only, the free piston C advancing near to the exhaust port G^1 during the exhaust stroke, and clearing out all the products of combustion except so much as will prevent metallic contact between the pistons. (*Accepted December* 17, 1886).

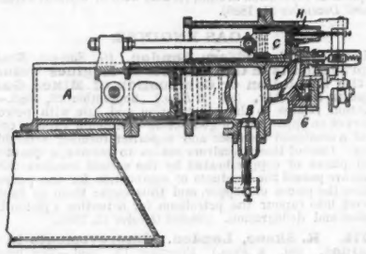
2653. M. P. W. Boulton, Tew Park, Oxford, and E. Perrett, London. Combined Steam and Gas Engines. [11*d.* 3 *Figs.*] February 23, 1886.—This invention relates to an engine worked partly by steam and partly by gas or inflammable vapour. A is a pump drawing in air and gas, then compressing the same and discharging the mixture by the valve a^3 into the lower part of the cylinder B, where it is ignited by means of the igniter b^1, and forces up the piston. The waste pro-



ducts are discharged into the atmosphere by the valve b^2. The piston is then forced down by steam introduced from a boiler through a valve b^4. The steam exhausts into the atmosphere or a condenser through the valve b^5. The supply of the explosive charge below the piston of the cylinder B is controlled by a slide valve *b* which, like the other valves, is operated by an eccentric on the crankshaft. An additional cylinder may be employed to expand the gaseous products and the steam. (*Sealed February* 18, 1887).

3473. C. Davy, Sheffield. An Improvement in Gas Engines. [8*d.* 3 *Figs.*] March 11, 1886.—According to this invention the charge of gas and air is injected into the axial centre of the combustion chamber (which is already filled with a mixture of air and residual inert gases compressed to a suitable pressure) in such a manner that it will occupy a central longitudinal position therein without spreading to any great extent radially, so that the charge will form a sort of combustible core or cartridge encircled by a belt of non-combustible gases which isolate the charge from the walls of the cylinder, thus preventing loss of heat, and rendering a water jacket unnecessary. A is the working cylinder, and B its piston giving motion to the crankshaft. C is the pump piston connected by its rod to an arm cast on the piston B, so that the pistons B and C move together. A passage E controlled by a delivery valve F leads from the end of the pump

cylinder centrally through the end of the working cylinder A. This engine works on the well-known four-cycle principle. During the second instroke which completes the cycle, and is made by the momentum of the flywheel, the exhaust valve I is closed, and the air and residual gases contained in the cylinder are compressed. The combustible charge admitted by the air and gas



valve H, also becomes compressed in the pump cylinder, and at a suitable point of the stroke, the delivery valve F is opened and allows the combustible charge to pass rapidly into the working cylinder, where it occupies a central longitudinal position surrounded by a belt of non-combustible mixture. The ignition of the charge takes place through the ignition slide valve G. (*Accepted January* 15, 1887).

PETROLEUM ENGINES.

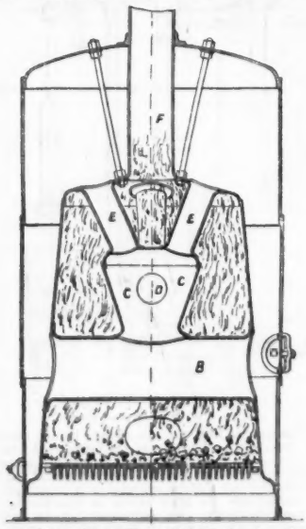
12,896. M. V. Schiltz, Cologne, Germany. Improvements in Gas and Petroleum Engines. [11*d.* 9 *Figs.*] October 27, 1885.—This invention relates to engines worked with heated explosion chamber or chambers described in a former patent granted to the same inventor. All accessory apparatus through which the petroleum flows is heated so as to prevent condensation. The petroleum is evaporated in metallic vessels arranged in the explosion chamber, but hermetically separated therefrom, in order to store the heat of explosion, and utilise it for evaporating the petroleum. Small metallic particles are used in combination with the evaporating vessels, in order to produce a large evaporating surface. The pressure of the petroleum mixture is regulated, and the heavy condensed petroleum is separated, by means of a gasometer. The heated chamber for igniting the compressed petroleum mixture is arranged in or on the slide valve cover. (*Sealed November* 2, 1886).

2140. E. Capitaine and F. Brunler, Berlin. Improvements in Oil, Petroleum, Naphtha, and similar Motors. [8*d.* 2 *Figs.*] February 13, 1886.—The improvements consist in the arrangement within the piston of an appliance for finely dividing or sprinkling the petroleum or other hydro-carbon used for driving the engine. (*Accepted December* 14, 1886).

BOILERS.

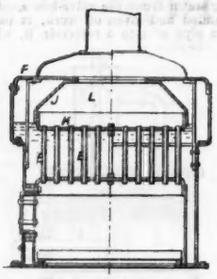
14,818. L. Petry, Duren, and W. Walther, Deutz, Germany. Improvements in Tubular Steam Generators. [8*d.* 5 *Figs.*] December 2, 1885.—According to this invention the water tubes are made to lie in horizontal and inclined rows. The inclined rows are connected to inclined connecting tubes of rectangular section lying closely side by side and forming together rectangular water chambers having inclined partitions formed by the sides of the separate tubes. (*Sealed November* 26, 1886).

5501. C. C. Marley, Middlesbrough, Yorks. Improvement in Vertical Steam Boilers, Having for its Objects a Large Amount of Heating Surface Coupled with Ease of Access thereto for Cleaning and Repairing Purposes. [6*d.* 1 *Fig.*] April 21, 1886.—The improvement consists of a tube B placed directly across the firebox,



and approached by a door in the outside shell. A water space C of inverted conical shape is situated in the middle of the tube B. From the sides of the box C are water tubes D, placed at right angles to the tube B, and three tubes E, slightly tapered, are connected at equal distances apart to the box C and the crown of the firebox. (*Accepted January* 5, 1887).

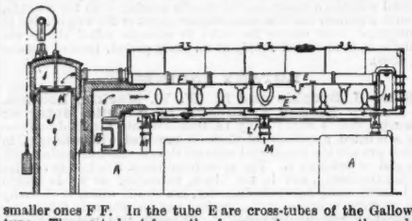
2466. F. C. Simpson, J. B. Denison, and E. F. Denison, Dartmouth, Devon. An Improved Construction or Arrangement of Vertical Steam Boiler. [6*d.* 2 *Figs.*] February 18, 1886.—This invention relates to an improvement on a special construction of boiler patented by G. Kingdon, Kingswear, Devon, in 1881. According to the present invention, the internal portion of the top plate F is made of ring shape, and from it is carried down at any desired angle a screen or partition J, to which the upper tubeplate K is attached, so as to be below the water level, or about level therewith, the tubes E being much shorter, and more steam space being obtained without interfering with the water space. A gas expansion chamber L is also formed



between the upper tubeplate K and the top plate F, in which a high temperature is obtained for drying the steam in the steam chamber. (*Accepted December* 21, 1886).

BOILER FURNACES.

3020. W. Beesley and J. Beesley, Barrow-in-Furness, Lancaster. Improvements in Steam Boilers Applicable for Utilising the Waste Heat from Puddling, Forge, Mill, or other Furnaces. [8*d.* 7 *Figs.*] March 3, 1886.—According to this invention a horizontal cylindrical boiler is arranged above the reheating or other furnace A, resting on metal saddles or cross-girders L carried on supporting columns M standing on each side of the furnace. The boiler is provided with a large lower tube or internal flue E, and two upper



smaller ones F F. In the tube E are cross-tubes of the Galloway type. The waste heat from the furnace A passes up the neck B lined with refractory material, through the large tube E into the end chamber H, where the heat is divided and returns through the two upper smaller tubes F, to meet again in the connecting flue I, and be carried off in the downtake J to the chimney. K is a damper with chain and balance mechanism as shown. (*Accepted January* 5, 1887).

8880. H. J. Haddan, London. (*H. Welsh, New York, U.S.A.*) **Improvements in Apparatus for Promoting the Combustion of Fuel.** [6*d.* 5 *Figs.*] July 7, 1886.—Inventor claims in an apparatus for conducting atmospheric air to the furnace of a steam generator, the combination with one or more pipes open to the atmosphere at one end, and forming a communication with one or more flue spaces located adjacent to the furnace, and separated therefrom by a perforated partition, of a branch pipe or pipes leading from the chimney, provided with dampers to regulatate the admission of the heated gases, and a steam jet located at the mouth of the air-conducting pipes. (*Sealed October* 15, 1886).

11,711. J. E. Brown, Slaithwaite, Yorks. Means of Consuming Smoke in Steam Boiler Furnaces. [6*d.* 4 *Figs.*] September 15, 1886.—The furnace bridge consists of one chamber only, having a perforated front facing the furnace, the open bottom of the bridge resting simply on the firebars, for the purpose of causing a current of heated air to be brought into intimate contact with the products of combustion before the crown of the furnace bridge. (*Sealed December* 21, 1886).

MISCELLANEOUS.

10,859. G. Correll, Erleigh, Berks. (*H. Correll, Heidelberg, Germany.*) **Improved Lubricator for Steam Cylinders, Slides, and the like.** [8*d.* 1 *Fig.*] September 14, 1885.—This invention relates to a simple form of lubricator chiefly for lubricating locomotive engine cylinders whilst the engine is going with the steam shut off. (*Sealed October* 22, 1886).

12,627. A. M. Clark, London. (*M. Honigmann, Grevenberg, Germany.*) **Improvements in the Fireless Working of Steam Engines and in the Means for Concentrating the Spent Lye Employed therein.** [11*d.* 2 *Figs.*] October 21, 1885.—The steam produced by the reconcentration of the lye is injected into the water tubes of the soda steam boiler, and becomes condensed therein, the heat being utilised for concentrating the soda in the soda steam boiler, and a check valve preventing the return of the water to the concentrator. The escaping steam from the soda in the soda steam boiler is used for increasing the draught in the furnace of the concentrating apparatus. The lye is pumped from the soda steam boiler into the concentrating boiler, a self-acting valve allowing the concentrated lye to flow back to the soda steam boiler. The temperature of the absorbing lye is always higher than its atmospheric boiling point, and the exhaust steam always reaches the soda at a pressure above that of the atmosphere. (*Sealed October* 22, 1886).

13,355. A. Barrett, Saffron Walden, Essex. An Improved Alarm Apparatus Applicable to Steam Boilers, Tanks, or the like. [8*d.* 2 *Figs.*] November 4, 1885.—The apparatus consists mainly of a pivotting or oscillating tube communicating with the interior of the boiler, and provided with a chamber having a suitable outlet. On the water sinking below the normal level the chamber runs empty and rises, closing an electric circuit, or putting a steam whistle into communication with the steam space of the boiler. (*Sealed November* 2, 1886).

13,656. B. Law, Birmingham, and C. W. Pinkey, Smethwick, Staffs. A New or Improved Combined Safety Governor and Alarm Sight Feed Lubricator for Steam and Compressed Air Engines. [8*d.* 4 *Figs.*] November 10, 1885.—Steam is cut off both when the governor balls are at their lowest as well as at their highest positions. When the lubricant is exhausted a lever connected to a float opens a valve that admits steam to an alarm whistle. (*Sealed October* 22, 1886).

15,379. F. M. Wheeler, Montclair, New Jersey, U.S.A. Improvements in Surface Condensers. [8*d.* 7 *Figs.*] December 15, 1885.—The improvements have the object of facilitating the insertion of the tubes and their removal for cleaning and repairs, and also of economising the condensing water, and preventing the chilling of the water of condensation, so that the latter may be returned to the boiler at as high a temperature as possible. (*Accepted December* 10, 1886).

15,475. W. von Ruckteschell, St. Petersburg. An Improved Explosive Engine. [1*s.* 3*d.* 12 *Figs.*] December 16, 1885.—According to this invention, nitro-cellulose or other material possessing similar properties, is introduced into a cylinder provided with a piston, and converted without combustion into a gaseous state by electricity or any other means producing a strong and sudden expansion or heat, whereby, besides the powerful expansion resulting from the formation of the gases, heat is rendered latent, and the machine is protected from overheating, whilst the expanded gases may be expelled unburnt, and thus be utilised. (*Sealed January* 11, 1887).

15,618. W. Hartcliffe and W. H. Malkin, Salford, Lancaster. Valve for Water Gauges, Junctions, or for other Purposes. [8*d.* 5 *Figs.*] December 19, 1885.—The improved valve consists of two valves and valve stems contained in one body, with one valve stem passing through a loop or opening in the other valve stem in such a manner that the two valves can work or be worked independently of each other. (*Sealed December* 28, 1886).

456. G. M. Marchant, Huddersfield, Yorks. Steam and Water Valves or Stop-Cocks. [8*d.* 7 *Figs.*] January 12, 1886.—This invention relates to a split valve or plug with or without an opening through it for the passage of the steam or water. (*Accepted November* 12, 1886).

1037. J. L. Wade, Glasgow. Compound for Preventing and Removing Incrustation in Steam Boilers. [6*d.*] January 23, 1886.—The improved compound contains caustic potash, esparto grass, valonia, nutgalls, carbonate and chloride of potash, silicate of soda, and chestnut flour. (*Accepted November* 23, 1886).

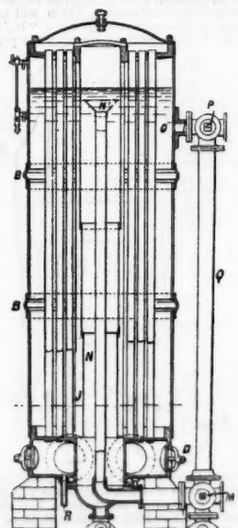
2177. J. Dewrance, London. Regulator Valve for Locomotives. [6*d.* 4 *Figs.*] February 15, 1886.—The valve is of the equilibrium type, and consists of two connected metal discs arranged to slide longitudinally within two rings of asbestos packing compressed by glands. Metal rings connected with the valve spindle cover the packing ring when the valve is open, and protect them from the rush of steam. (*Accepted December* 17, 1886).

2178. J. Dewrance, London. Lubricants for Steam Cylinders. [4*d.*] February 15, 1886.—The improved lubricant consists of a mixture of plumbago and lead soap. (*Accepted December* 17, 1886).

2376. S. Fox, Leeds. Means of Preventing Incrustation of Certain Parts of Steam Boilers. [8*d.* 2 *Figs.*] February 18, 1886.—According to this invention scrapers of suitable form depending upon the shape of the firebox or flue (corrugated or otherwise) are arranged upon, and so as to bear against the surfaces upon which accumulation of sediment is to be prevented. A to-and-fro motion is imparted to the scrapers by hand or otherwise through chains and rods and windlasses, or other mechanism. (*Accepted December* 17, 1886).

11,098. J. Bond, Richmond, Virginia, U.S.A. Improvements in and Connected with Boiler Cleaners. [8*d.* 7 *Figs.*] August 31, 1886.—The improved boiler cleaner consists of a triangular plate secured within the boiler just below the surface of the water, and extending at its forward edge from side to side of the boiler. This plate is provided with upwardly turned side flanges which meet together at the rear. A pipe with an inverted funnel-shaped lower end, extends from a point just within the junction of the sides and above the plate through the boiler side to a mud drum. The generation of steam in the boiler operates to cause a current of water through the pipe to the mud drum and thence by another pipe back to the boiler. The currents in passing rearward deposit upon the triangular plate all foreign matter contained in the water. (*Sealed December* 10, 1886).

15,778. C. A. Knight, Glasgow, N.B. Improvements in Apparatus for Heating and Purifying the Feed Water Supplied to Steam Boilers. [8*d.* 3 *Figs.*] December 2, 1886.—The outer shell is built up in sections connected by expansion rings B. The feed water is discharged by a pump at the mouth N¹ of the internal tube N, and descends within the



cylindrical chamber J, passing outwards at its lower extremity and upwards around the heating tubes to the orifice O leading to the boiler. All sediment or scum is discharged through the cock L. Pipes R serve to drain the condensation from the steam chest D. The heater may be shut off from use by means of the external pipe Q and the three-way cocks M and P. The pump in this case feeds direct to the boilers. (*Accepted January* 5, 1887)

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

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THIS Directory is intended to meet the requirements of those who may wish to ascertain at a glance the names of makers of any article advertised in ENGINEERING; for detailed particulars, the advertisements of the Firms indicated in this list may readily be found on reference to the alphabetical index of names published every week on page v. of our advertisements. If the advertisement sought for should not be found in the Number of ENGINEERING in which search is first made, it will probably be in the Number immediately preceding or following, many advertisements being inserted every other week only, whilst some few appear at longer intervals.

Copies of this DIRECTORY, in a compact book form, are regularly sent to the PRINCIPAL HOME AND FOREIGN MERCHANTS, as well as to AGENTS and SHIPPERS OF MACHINERY in this country and abroad; also to the BRITISH CONSULS ABROAD, and to the Heads of Departments of FOREIGN AND COLONIAL RAILWAYS. They may also be had gratis, on application to the publisher. With these DIRECTORIES is incorporated a complete List of the Telegraphic Addresses of Advertisers in ENGINEERING, together with a Key to the same.

Accumulators.

Electrical Power Storage Co., Ltd. 4, Great Winchester St., E.C.
Elwell-Parker, Limited .. .. Wolverhampton

Agricultural Machinery.

Clayton & Shuttleworth .. .. Lincoln
Davey, Paxman & Co. .. .. Colchester
Foster, W., & Co., Limited .. Lincoln
Fowler, J., & Co. (Leeds), Ltd. .. Leeds
Garrett, R., & Sons .. .. Leiston Works, Suffolk
Hornsby & Sons, Limited .. Grantham
Marshall, Sons & Co., Limited .. Gainsborough
Ransomes, Sims, & Jefferies, Ltd. Ipswich
Reading Ironworks Co., Limited Reading
Robey & Co. .. .. .. Lincoln
Ruston, Proctor & Co. .. .. Lincoln

Air Compressors.

Brotherhood, P. .. .. .. Belvedere Road, S.E.
Carrick & Wardale .. .. Gateshead-on-Tyne
Clayton, Howlett & Venables .. Harrow Road, W.
Coles, H. J. .. .. .. Sumner Street, S.E.
Day & English .. .. .. Bath
Grange Iron Co., Limited .. Durham
Hartley, Arnoux & Fanning .. Stoke-on-Trent
Hathorn, Davey & Co. .. .. Leeds
Hughes & Lancaster .. .. Chester
Jordan, T. B., Son & Commans. 52, Gracechurch Street, E.C.
Körting Brothers .. .. .. 11, Pancras Lane, Queen St., E.C.
Larmuth, T., & Co. .. .. Salford, Manchester
Miller & Co. .. .. .. Vulcan Foundry, Coatbridge
Ormerod, Grierson & Co. .. St. George's Ironworks, Manchester
Sandycroft Foundry and Engine Works Co., Limited, The .. Near Chester
Schram, Richard, & Co. .. .. 9, Northumberland Street, W.C.
Scott, Geo., & Son .. .. .. 44, Christian Street, E.
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Thwaites Brothers .. .. .. Bradford
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Westinghouse Brake Co., Ltd. .. York Road, King's Cross, N.

Anchors.

Wright, Joseph & Co. .. .. Tipton

Anti-Corrosive Composition.

Palfreyman, W. H., & Co. .. 87, Piccadilly, Manchester

Arbitrators.

Kirk, W., Price & Goulty .. 52, Queen Victoria Street, E.C.

Asbestos Goods, Fittings, &c.

Asbestos Co., Ltd. (The United) 161, Queen Victoria Street, E.C.
Bell, J., & Son .. .. .. Asbestos Works, Southwark, S.E.
Wotherspoon, James, & Sons .. Glasgow

Auctioneers.

Hobson, Wm. H. .. .. .. Suffolk House, Laurence Pountney Hill, E.C.
Kirk, W., Price & Goulty .. Albert Square, Manchester

Barge Builders.

Cumming, W. S. .. .. .. Blackhill Dock, Glasgow

Bars (Steel and Iron).

Beardmore, William, & Co. .. Parkhead Ironworks, Glasgow
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bayley, Dixon & Co., Ltd. Sheffield
Coats Iron & Steel Co. .. .. Coatbridge, N.B.
Colville, David, & Sons .. .. Motherwell, near Glasgow
Darlington Steel & Iron Co., Ltd. Darlington
Firth, Thos., & Sons, Ltd. .. Sheffield
Glasgow Iron Co. .. .. .. 168, St. Vincent Street, Glasgow
Leeds Forge Co., Limited .. Leeds
Shelton Iron & Steel Co., Ltd. .. Stoke-on-Trent, and 122, Cannon Street, London, E.C.
Spencer, John, & Sons .. .. Newburn Steelworks, Newcastle-on-Tyne
Steel Co. of Scotland .. .. Glasgow [castle-on-Tyne

Belts (Driving).

Binnsy & Son (Linen) .. .. Catherine St., City Rd., E.C.
Fleming, T., Son & Co. .. .. West Grove Mill, Halifax
Gehrckens, C. Otto .. .. .. Grosse Backerstrasse 12, Hamburg
I. R. G. P. & T. Works Co., Ltd. Silvertown, Essex
Lancashire Patent Belting and Hose Co. .. .. .. Strangeways, Manchester
McIntosh, Peter, & Sons .. .. 129a, Stockwell St., Glasgow
Moseley, David, & Sons .. .. Ardwick, Manchester
Norris, S. E., & Co. .. .. 56, High Street, Shadwell, E.
Okes, J. C. R. .. .. .. 39, Queen Victoria Street, E.C.
Patent Anhydrous Leather Co. Portsmouth
Sutcliffe Bros. .. .. .. Atlas Wks., Godley, Manchester
Tullis, John, & Son .. .. .. St. Ann's Leather Wks., Glasgow
Webb & Son .. .. Combe Tannery, Stowmarket
Wilcock, Mark .. .. .. Sowerby Bridge
Wilson, J. Veitch, Halliday & Co. Queen Street (Bradford), Manchester

Bleaching Machinery.

Mather & Platt .. .. .. Salford Iron Wks., Manchester
Musgrave, John, & Sons .. .. Bolton

Blowers.—*(See Fans.)*

Boiler Cleaners.

Nelson, Horatio .. .. .. 90, Worship St., London, E.C.

Boiler Furnaces.

Deakin, B., & Co. .. .. .. Southwark Park Rd. Bermondsey
Leeds Forge Co., Limited .. Leeds

Boiler Manholes.

Galloway, W. & J., & Sons .. Manchester
Leeds Forge Co., Limited .. Leeds
M'Best, C., Jr. .. .. .. Kinning Park Ironworks, Glasgow
Spencer, John, & Sons .. .. Newburn Steelworks, Newcastle-on-Tyne

Boilers (Steam).

Adamson, Joseph, & Co. .. .. Hyde, near Manchester
Aitken, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Alley & Maclellan .. .. .. Sentinel Works, Glasgow
Appleby Brothers, Limited .. East Greenwich
Appleby, Chas., & Co. .. .. 89, Cannon Street, E.C.
Arrol Brothers .. .. .. Germiston Ironworks, Petershill Road, Glasgow
Ashmore, Benson, Pease & Co., Ltd Stockton-on-Tees
Babcock & Wilcox Co. .. .. 107, Hope Street, Glasgow
Bellamy, John .. .. .. Byng Street, Millwall, E.
Bellevile, J., & Co. .. .. 4 St. Denis, Seine
Bellis, G. E., & Co. .. .. Ledsam St. Works, Birmingham
Blaikie Bros. .. .. .. Aberdeen, N.B.
Blake, James .. .. .. Newton Heath, Manchester
Bodley Brothers & Co. .. .. Exeter
Bons, F. G. .. .. Long Lane, Bermondsey
Buckley & Taylor .. .. .. Castle Ironworks, Oldham
Burnet, L., & Co. .. .. .. Govan, Glasgow
Burrell, C., & Sons, Limited .. Thetford
Chaplin, Alex., & Co. .. .. Cranstonhill Engine Works, Glasgow
Cochran & Co. .. .. .. Birkenhead
Coltman, H., & Son .. .. Loughborough
Copeland, J. & Co. .. .. Dobbie's Loan, Glasgow
Davey, Paxman & Co. .. .. Colchester
Davy Brothers, Limited .. .. Sheffield
Easton & Anderson .. .. 3, Whitehall Pl., London, S.W.
Fawcett, Thomas C. .. .. Old Victoria Foundry, Manor Rd.
Fernihough, John, & Sons .. Stalybridge, Lancashire [Leeds
Foster, W., & Co., Limited .. Lincoln
Fowler, J., & Co. (Leeds), Ltd. .. Leeds
Fraser and Fraser .. .. .. Bromley-by-Bow, E.
Galloway, W. & J., & Sons .. Manchester
Garrett, R., & Sons, Limited .. Leiston Works, Suffolk
Goodwin, J., & Co. .. .. Motherwell, N.B.
Grange Iron Co., Limited .. Durham
Grantham Crank and Iron Co., Ltd., The .. .. .. Grantham
Hanna, Donald & Wilson .. .. Paisley, N.B.
Hardingham, G. G. M. .. .. 191, Fleet Street, London, E.C.
Hartley, Arnoux & Fanning .. Stoke-on-Trent
Hartley & Sugden, Limited .. Halifax
Hawthorn, R. & W., Leslie, & Co. Limited .. .. Newcastle-on-Tyne
Hayes, Ed. .. .. Stony Stratford
Hick, Hargreaves & Co. .. .. Soho Ironworks, Bolton
Hornsby, R., & Sons, Limited .. Grantham
Horton, J. & W. .. .. .. Sandwick, near Birmingham
Isca Foundry & Engineering Co. Newport, Mon.
Kincaid & Co. .. .. .. Clyde Foundry, Greenock, N.B.
Knap, Conrad, & Co. .. .. 11, Queen Victoria Street, E.C.
Leeds Forge Co., Limited .. Leeds
Machinery & Hardware Co., Ltd. 147, Queen Victoria Street, E.C.
Manlove, Alliott, Fryer & Co. .. Nottingham
Marshall, Sons & Co., Limited .. Gainsborough [Coventry
Matthews, F. S. .. .. .. Lancashire Boiler Works,
Mather & Platt .. .. .. Salford Iron Wks., Manchester
Musgrave, J., & Sons .. .. Bolton [Glasgow
Norman, J., & Co. .. .. .. Keppochill Engine Works,
Oldham Boiler Works Co. .. Oldham
Olrick, L., & Co. .. .. .. 27, Leadenhall Street, E.C.
Ormerod, Grierson & Co. .. St. George's Ironworks, Manchester
Patent Steam Boiler Co. .. .. Heneage Street, Birmingham
Paul, M. & Co. .. .. .. Levenford Works, Dumbarton
Penman & Co. .. .. .. 377, Dalmarnock Rd., Glasgow
Picking, Hopkins & Co. .. .. Bow, London, E.
Piggott, Thos., & Co. .. .. Springhill, Birmingham
Plenty & Son .. .. Eagle Ironworks, Newbury, [Berks
Ransomes, Sims, & Jefferies, Ld. Ipswich
Reading Ironworks Co., Limited Reading
Robey & Co. .. .. Lincoln
Rose, Downs & Thompson .. .. Hull
Rose & Duncan .. .. Glasgow
Russell, Geo., & Co. .. .. Motherwell, near Glasgow
Ruston, Proctor & Co. .. .. Lincoln
Sandycroft Foundry and Engine Works Co., Limited, The .. Near Chester
Schram, Richard, & Co. .. .. 9, Northumberland Street, W.C.
Shanks, Alexander, & Son .. Dens Ironworks, Arbroath
Smedley Brothers .. .. .. Belper
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Tinker, Shenton & Co. .. .. Hyde, near Manchester
Vosper & Co. .. .. .. Portsmouth
Walker Brothers .. .. .. Pagefield Ironworks, Wigan

Bolts, Rivets, Nuts, Screws, &c.

Baylis, Jones, and Baylis .. Victoria Wks., Wolverhampton
Child Brothers .. .. .. Falcon Works, Smethwick, near Birmingham
Clyde Rivet Works Co. .. .. Glasgow [Birmingham
Cocker Bros., Ltd. .. .. .. Sheffield
Galloway, W. & J., & Sons .. Manchester
Ibbotson Bros. & Co., Limited .. Sheffield
Miller, James, & Co. .. .. 204, Stobcross Street, Glasgow
Phœnix Bolt & Nut Co. .. .. Handsworth, nr. Birmingham
Smith, Ford .. .. .. Ordsal Lane, Salford, Manchester

Brakes (Railway)

Westinghouse Brake Co. .. .. Canal Road, King's Cross, N.

Brass Founders and Brass Finishers.

Bailey, W. H., & Co. .. .. Albion Wks, Salford, Manchester
Billington & Newton .. .. Longport, Staffordshire
Blair, Campbell, & M'Lean .. Scotland St. Copper Works, Glasgow
Bodley Brothers & Co. .. .. Exeter
Cockshott & Jowett .. .. Bradford
Foster, Edward, & Son .. .. Halifax
Hughes, J. & J. .. .. .. Birmingham
Hunter & English .. .. .. Bow, London, E.
Picking, Hopkins & Co. .. .. Bow, London, E.
Piggott, Thos., & Co. .. .. Springhill, Birmingham
Rhodes, B. .. .. Bow Brass Works, London, E.
Savile Street Foundry and Engineering Co., Limited .. Sheffield
Scott, Ernest, & Co. .. .. Close Wks., Newcastle-on-Tyne
Steven & Struthers .. .. Glasgow
Stewart, A. & C. .. .. .. Port Eglinton Brass Foundry, Glasgow
Storer, I., & Sons .. .. .. Knott Mill, Manchester

Bread-Making Machinery.

Drysdale & Co. .. .. .. Bon Accord Eng. Wks., Glasgow
Pfleiderer, Paul .. .. .. 86, Upper Ground Street, S.E.

Brewery and Distillery Plant.

Blaikie Bros. .. .. .. Aberdeen, N.B.
Blair, Campbell, & M'Lean .. Scotland St. Copper Works, Glasgow
Carron Co. .. .. Carron Wks., Stirlingshire, N.B.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Hunter & English .. .. .. Bow, London, E.
Moreland, Richard, & Son .. 8, Old Street, E.C.
Picking, Hopkins & Co. .. .. Bow, London, E.

Brick and Tile Making Machinery.

Bradley & Craven .. .. .. Westgate Common Foundry, Wakefield
Clayton, Howlett & Venables .. Harrow Road, London [Leeds
Fawcett, Thomas C. .. .. Old Victoria Foundry, Manor Rd.
Johnson, William .. .. .. Castleton Foundry, Armley Road, Leeds
Middleton, Thos., & Co. .. .. Lomon Street, Southwark, S.E.
Patent Brick Machine Co. .. Middlesbro'-on-Tees

Bricks.

Burham Brick, Lime, & Cement Co. .. .. Nicholas Lane, E.C.
Lowood, J. Grayson, & Co. .. 80, Attercliffe Road, Sheffield

Bridge Foundation Cylinders.

Hanna, Donald & Wilson .. Paisley
Isca Foundry & Engineering Co. Newport, Mon.
Stockton Forge Co. .. .. Stockton-on-Tees

Bridges.

Appleby Brothers, Limited .. East Greenwich
Appleby, Chas., & Co. .. .. 89, Cannon Street, E.C.
Arrol Brothers .. .. .. Germiston Ironworks, Petershill Road, Glasgow
Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Ashmore, Benson, Pease & Co., Ltd. Stockton-on-Tees
Blaikie Bros. .. .. .. Aberdeen, N.B.
De Bergue & Co., Limited .. Manchester
Dyle & Bacalan, Limited .. 60, Fenchurch Street, E.C.
Firth, Thos., & Sons, Limited .. Sheffield
Goodwin, J., & Co. .. .. Motherwell, N.B.
Hanna, Donald & Wilson .. Paisley
Harpers Limited .. .. .. Aberdeen, Scotland
Heenan & Froude .. .. .. Newton Heath Ironworks, near Manchester
Isca Foundry & Engineering Co. Newport, Monmouthshire
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Westwood, Baillie & Co. .. .. London Yard, Poplar, E.

Buffers.

Gloucester Wagon Co., Ltd. .. Gloucester
Ibbotson Bros. & Co., Limited .. Sheffield
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Spencer, J., & Sons .. .. Newburn Steel Works, Newcastle-on-Tyne
Turton, Geo. .. .. .. Figtree Lane, Sheffield
Turton, T., & Sons, Ltd. .. Sheaf Works, Sheffield

Buoys (Iron and Steel).

Bellamy, John .. .. .. Byng Street, Millwall, E.

Cables (Electric Light, Telegraph and Telephone).

Johnson & Phillips .. .. 14, Union Ct., Old Broad St., E.C.
Kinetic Engineering Co. .. 89, St. Martin's Lane, W.C.

Carbons for Electrical Purposes (Manufacturers of).

Johnson & Phillips .. .. 14, Union Ct., Old Broad St., E.C.
Woodhouse and Rawson .. .. 11, Queen Victoria Street, E.C.

Carriage (Railway) Builders.

Ashbury Railway Carriage and Iron Co., Limited .. .. Openshaw, Manchester
Falcon Engine and Car Works, Limited .. .. .. Loughborough
Gloucester Wagon Co., Limited Gloucester
Metropolitan Railway Carriage and Wagon Co., Limited .. Saltley Works, Birmingham
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury

Castings (Iron).

Bodley Brothers & Co. .. .. Exeter
Carrick & Wardale .. .. .. Gateshead
Carron Co. .. .. Carron Wks., Stirlingshire, N.B.
Clay Cross Co. .. .. .. Clay Cross, near Chesterfield
Clayton, Howlett & Venables .. Harrow Road, London, W.
Cockshott & Jowett .. .. Thornton Road, Bradford
Goodwin, J., & Co. .. .. Motherwell, N.B.
Grange Iron Co., Limited .. Durham
Harpers Limited .. .. .. Aberdeen
Hind, H., & Son .. .. .. Nottingham
Hunter & English .. .. .. Bow, London, E.
Isca Foundry & Engineering Co. Newport, Mon.
Macfarlane, Walter, & Co. .. Possilpark, Glasgow
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Ormerod, Grierson & Co. .. Holme, Manchester
Savile Street Foundry and Engineering Co., Limited .. Sheffield

Castings (Malleable Iron).

Crowley, John, & Co. .. .. Sheffield
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Castings (Steel).

Appleby, Chas., & Co. .. .. 89, Cannon Street, E.C.
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bayley, Dixon & Co. .. Sheffield
Catton & Co. .. .. .. Dewsbury Road, Leeds
Darlington Steel & Iron Co., Ltd. Darlington
Firth, Thos., & Sons, Limited .. Sheffield
Fox, Edwin, & Co., Ltd. .. .. Millwall
Hansell & Co. .. .. .. Canal Works, Sheffield
Jessop, Wm., & Sons .. .. Sheffield
Korten, M. .. .. 17, Gracechurch Street, E.C.
Osborn, S., & Co. .. .. .. Sheffield
Reichwald, A. .. .. .. Newcastle-on-Tyne
Savile Street Foundry and Engineering Co., Limited .. .. Sheffield [castle-on-Tyne
Spencer, John, & Sons .. .. Newburn Steelworks, Newcastle-on-Tyne
Stanners Close's Steel Co. .. Wolsingham, viâ Darlington
Steel Co. of Scotland, Ltd., The Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Cement.

Burge & Barron .. .. .. Rainham, Kent
Burham Brick, Lime and Cement Co., Limited .. .. Nicholas Lane, E.C.
Formby's Cement Works Co., Ltd. 142, Grosvenor Road, S.W.
Francis & Co., Ltd. .. .. Vauxhall, S.W.
Francis, C., Son & Co. .. .. 17, Gracechurch Street, E.C.
Greaves, Bull & Lakin .. .. Warwick
Haacke, A., & Co. .. .. .. Kiesselguhr Wharf, Gainsboro Road, Hackney Wick, E.
Rugby Portland Cement Co. .. Rugby, Warwickshire
Wouldham Cement Co. .. .. 39, Lime Street, E.C.

Cement Grinding Machinery.

Dell, Wm. R., & Son .. .. 26, Mark Lane, E.C.
Grange Iron Co., Limited .. Durham
Jordan, T. B., Son & Commans. 52, Gracechurch Street, E.C.
Ormerod, Grierson & Co. .. St. George's Ironworks, Manchester

Chains and Cables.

Dempster, Moore & Co. .. .. 49, Robertson Street, Glasgow
Hodgkinson & Co., Limited .. Manchester
Pickering, John .. .. .. Stockton-on-Tees
Wright, Jos., & Co. .. .. Tipton, Staffordshire

Chemical Works (Plant for).

Carrick & Wardale .. .. Gateshead
Grange Iron Co., Limited .. Durham
Piggott, Thos., & Co. .. .. Birmingham

Clocks and Watches.

Benson, J. W. .. .. .. 62 & 64, Ludgate Hill, E.C.

Clutches (Friction).

Bagshaw, J., & Sons .. .. Batley
Mather & Platt .. .. .. Salford Ironworks, Manchester
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Watson, Laidlaw & Co. .. .. Kingston, Glasgow

Coal Cutting Machines.

Grange Iron Co., Limited .. Durham

Coal Merchants.

Clay Cross Co. .. .. .. Clay Cross, near Chesterfield

Colliery Plant.

Black, Hawthorn & Co. .. .. Gateshead-on-Tyne
Clay Cross Co. .. .. .. Clay Cross, near Chesterfield
Davy Brothers, Limited .. .. Sheffield
Goodwin, James, & Co. .. .. Ardrossan, N.B.
Grange Iron Co., Limited .. Durham
Hathorn, Davey & Co. .. .. Leeds
Hornsby, R., & Sons, Limited .. Grantham
Isca Foundry & Engineering Co. Newport, Mon.
Jordan, T. B., Son & Commans. 52, Gracechurch Street, E.C.
Miller & Co. .. .. Vulcan Foundry, Coatbridge
Sandycroft Foundry and Engine Works Co., Limited, The .. Near Chester
Walker Brothers .. .. .. Pagefield Ironworks, Wigan

Compasses.

Negretti & Zambra .. .. Holborn Viaduct, E.C.

Condensers (Fresh Water).

Chaplin, Alex., & Co. .. .. Cranstonhill Engine Works, Glasgow
Kirkaldy, John .. .. .. 49, West India Dock Road, E.
Normandy & Co. .. .. .. Custom House Station, Victoria Docks, E.
Suffield & Brown .. .. .. James St. and Devonport St., E.

Condensers (for Steam Engines).

Morton, Alexr., & Thomson .. 96, Buchanan Street, Glasgow
Suffield & Brown .. .. .. James St. and Devonport St., E.
Scott, Ernest, & Co. .. .. Close Wks., Newcastle-on-Tyne
Worthington Pumping Engine Co. 114, Queen Victoria Street, E.C.

Coppersmiths.

Birmingham Battery & Metal Co. Birmingham
Blair, Campbell, & M'Lean .. Scotland st. Copper Works, Glasgow
Storey, I., & Sons .. .. .. Knott Mill, Manchester

Cotton Presses.

Coles, H. J. .. .. .. Sumner Street, S.E.
Ormerod, Grierson & Co. .. St. George's Ironworks, Manchester
Piggott, Thos., & Co. .. .. Birmingham [chester
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Tyler, H., & Co. .. .. .. 84, Upper Whitecross St., E.C.